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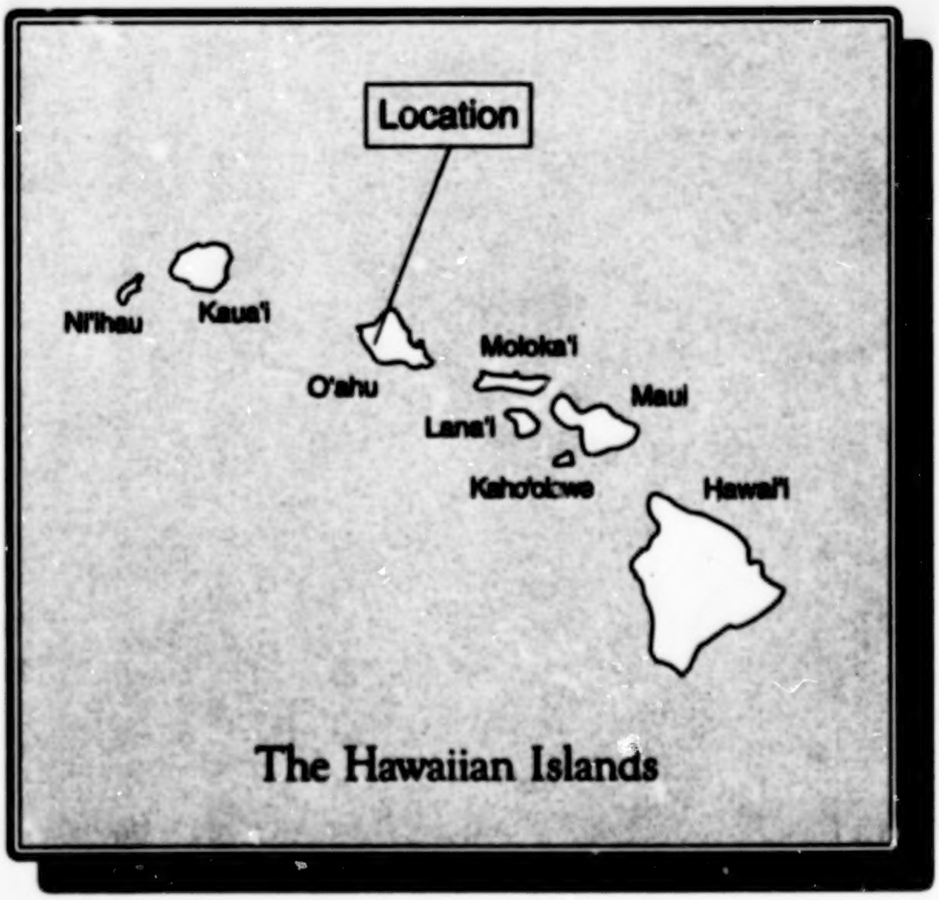
RECOVERY PLAN FOR THE WAIANAE PLANT CLUSTER

JULY, 1995



The Hawaiian Islands

U.S. Fish and Wildlife Service, Pacific Region

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RECOVERY PLAN FOR THE WAIANAE PLANT CLUSTER

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EXECUTIVE SUMMARY

Current Species Status: All 31 taxa are federally listed as endangered with numbers of known remaining individuals as follows: (# of populations, # individuals) *Abutilon sandwicense* (no common name (NCN)) (12, 280-290), *Alsinidendron obovatum* (NCN) (3, 11), *Alsinidendron trinerve* (NCN) (2, 32), *Centaurium sebaeoides* ('awiwi) (8, 60-110), *Chamaesyce celastroides* var. *kaenana* ('akoko) (11, 545), *Chamaesyce kuwaleana* ('akoko) (3, 2,000), *Cyanea grimesiana* ssp. *obatae* (haha) (3, 17), *Cyanea pinnatifida* (haha) (1, 1), *Cyanea superba* (NCN) (2, <10), *Diellia falcata* (NCN) (21, 5,540-6,540), *Diellia unisora* (NCN) (4, 700), *Dubautia herbstobatae* (na'ena'e) (4, 3,000-4,000), *Gouania meyenii* (NCN) (7, 119), *Gouania vitifolia* (NCN) (1, 5), *Hedyotis degeneri* (NCN) (3, 32), *Hedyotis parvula* (NCN) (4, 225-235), *Hesperomannia arbuscula* (NCN) (6, 86), *Lipochaeta lobata* var. *leptophylla* (nehe) (3, 100), *Lipochaeta tenuifolia* (nehe) (8, 2,000), *Lobelia niihauensis* (NCN) (33, 2,000), *Neraudia angulata* (NCN) (15, 109), *Nototrichium humile* (kulu'i) (15, 1,580-1,610), *Phyllostegia mollis* (NCN) (5, 120-140), *Sanicula mariversa* (NCN) (2, 75), *Schiedea kaalae* (NCN) (6, 11), *Silene perlmanii* (NCN) (2, 2), *Stenogyne kanehoana* (NCN) (1, 2), *Tetramolopium filiforme* (NCN) (4, 1,500), *Tetramolopium lepidotum* ssp. *lepidotum* (NCN) (5, 94-115), *Urera kaalae* (opuhe) (9, 40), and *Viola chamissoniana* ssp. *chamissoniana* (pamakani) (6, 237).

Distributions: Twenty six of the 31 Waianae Recovery Plan taxa are either endemic to, or have their largest or best known populations in, the Waianae Mountain Range on the western side of the island of Oahu, Hawaii. The following taxa also have current populations outside the Waianae Range: *Centaurium sebaeoides* on the islands of Kauai, Molokai, Lanai, and West Maui, and in the Koolau Mountain range on Oahu; *Gouania meyenii* on Kauai; *Hesperomannia arbuscula* on West Maui; *Lobelia niihauensis* on Kauai; *Nototrichium humile* and *Phyllostegia mollis* on East Maui; *Schiedea kaalae* in the Koolau Mountain range on Oahu; and *Tetramolopium lepidotum* spp. *lepidotum* on Hawaii.

Habitat Requirements and Limiting Factors: The 31 taxa included in this recovery plan grow in a variety of vegetation communities (forests, shrubland, and volcanic cliffs), elevation zones (coastal to high cliff faces), and moisture regimes (dry to wet). These taxa and their habitats have been variously affected or are currently threatened by one or more of the following: trampling, predation, and habitat destruction by introduced ungulates; habitat degradation and competition for space, light, water, and nutrients by naturalized, alien vegetation; habitat loss from fires; insects and disease; predation by rodents and slugs; small number of individuals and populations; loss of pollinators; and introduced bird species. A few of these taxa may have been subjected to overcollection and are subject to trampling by human beings along trails. Because of the small number of extant individuals and severely restricted distributions, populations of these taxa are subject to an increased likelihood of extinction from stochastic events.

Recovery Objective: Delist all taxa. Interim, downlisting, and delisting objectives are provided. Recovery of the Waianae plant cluster taxa should be pursued via the establishment of management units in order to make the most efficient use of available resources in an effort to conserve not only these taxa, but their habitats as well.

Recovery Criteria:

Interim Objectives

The interim objective is to stabilize all existing populations of the Waianae cluster taxa. To be considered stable, each taxon must be managed to control threats (e.g., fenced) and be represented in an *ex situ* collection. In addition, a minimum total of three (3) populations of each taxon should be documented on Oahu, and, if possible, at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing and increasing in number, with a minimum of 25 mature individuals per population for long-lived perennials and a minimum of 50 mature individuals per population for short-lived perennials.

Downlisting Objectives

For downlisting, a total of five to seven (5-7) populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered.

Delisting Objectives

A total of eight to ten (8-10) populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years.

Actions Needed:

1. Protect habitat of current populations and manage threats.
2. Conduct research essential to conservation of the species.
3. Expand current populations, as needed.
4. Establish new populations as needed to reach recovery objectives.
5. Validate and revise recovery objectives.

Total Estimated Cost of Recovery ($1,000's):

Year	Need 1	Need 2	Need 3	Need 4	Need 5	Total
1995	146	0	125	0	0	271
1996	483	476	125	0	0	1084
1997	773	516	424	105	0	1818
1998	938	482	424	105	0	1949
1999	1275	482	424	105	0	2286
2000	1379	482	424	105	0	2390
2001	1080	311	424	105	0	1920
2002	1030	311	150	0	0	1491
2003	1030	311	150	0	0	1491
2004	1030	311	150	0	0	1491
2005	1030	311	125	0	0	1466
2006	1030	51	125	0	0	1206
2007	953	51	125	0	0	1129
2008	953	51	125	0	0	1129
2009	696	51	125	0	0	872
2010	536	51	125	0	0	712
2011	536	51	125	0	120	832
2012	536	51	125	0	120	832
2013	536	51	125	0	160	872
2014	536	51	125	0	40	752
2015	536	51	125	0	40	752
Total	17042	4503	4195	525	480	26745

Date of Recovery: To be determined once more is known about the biology and population dynamics of the Waianae Recovery Plan taxa.

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As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in island Territories under U.S. administration.

XV

PART I. INTRODUCTION

A. **Brief Overview**

This recovery plan (Waianae Recovery Plan) addresses 31 plant taxa which have been listed as endangered under the Endangered Species Act of 1973, as amended (Act), in four listing actions between September 1991 and June 1994: *Abutilon sandwicense* (no common name (NCN)) (USFWS 1991b); *Alsinidendron obovatum* (NCN) (USFWS 1991b); *Alsinidendron trinerve* (NCN) (USFWS 1991b); *Centaurium sebaeoides* ('awiwi) (USFWS 1991b); *Chamaesyce celastroides* var. *kaenana* ('akoko) (USFWS 1991b); *Chamaesyce kuwaleana* ('akoko) (USFWS 1991b); *Cyanea grimesiana* ssp. *obatae* (haha) (USFWS 1994); *Cyanea pinnatifida* (haha) (USFWS 1991b); *Cyanea superba* (NCN) (USFWS 1991a); *Diellia falcata* (NCN) (USFWS 1991b); *Diellia unisora* (NCN) (USFWS 1994); *Dubautia herbstobatae* (na'ena'e) (USFWS 1991b); *Gouania meyenii* (NCN) (USFWS 1991b); *Gouania vitifolia* (NCN) (USFWS 1994); *Hedyotis degeneri* (NCN) (USFWS 1991b); *Hedyotis parvula* (NCN) (USFWS 1991b); *Hesperomannia arbuscula* (NCN) (USFWS 1991b);, *Lipochaeta lobata* var. *leptophylla* (nehe) (USFWS 1991b); *Lipochaeta tenuifolia* (nehe) (USFWS 1991b); *Lobelia niihauensis* (NCN) (USFWS 1991b); *Neraudia angulata* (NCN) (USFWS 1991b); *Nototrichium humile* (kulu'i) (USFWS 1991b); *Phyllostegia mollis* (NCN) (USFWS 1991b); *Sanicula mariversa* (NCN) (USFWS 1991b); *Schiedea kaalae* (NCN) (USFWS 1991b); *Silene perlmanii* (NCN) (USFWS 1991b); *Stenogyne kanehoana* (NCN) (USFWS 1992); *Tetramolopium filiforme* (NCN) (USFWS 1991b); *Tetramolopium lepidotum* ssp. *lepidotum* (NCN) (USFWS 1991b); *Urera kaalae* (opuhe) (USFWS 1991b); and *Viola chamissoniana* ssp. *chamissoniana* (pamakani) (USFWS 1991b).

Abutilon sandwicense, *Alsinidendron obovatum*, *Alsinidendron trinerve*, *Chamaesyce celastroides* var. *kaenana*, *Chamaesyce kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyanea pinnatifida*, *Cyanea superba*, *Diellia falcata*, *Diellia unisora*, *Dubautia herbstobatae*, *Gouania meyenii*, *Gouania vitifolia*, *Hedyotis degeneri*, *Hedyotis parvula*, *Lipochaeta lobata* var. *leptophylla*, *Lipochaeta tenuifolia*, *Neraudia angulata*, *Phyllostegia mollis*, *Sanicula mariversa*, *Silene perlmanii*, *Stenogyne kanehoana*, *Tetramolopium filiforme*, *Tetramolopium lepidotum* ssp. *lepidotum*, *Urera kaalae*, and *Viola chamissoniana* ssp. *chamissoniana* are either endemic to, or have their largest or best known populations in, the Waianae Mountain Range on the western side of the island of Oahu, Hawaii. The following taxa also have current populations outside the Waianae Range: *Centaurium sebaeoides* on the islands of Kauai, Molokai, Lanai, and West Maui, and in the Koolau Mountain range on Oahu; *Gouania meyenii* on Kauai; *Hesperomannia arbuscula* on West Maui; *Lobelia niihauensis* on Kauai; *Nototrichium humile* and *Phyllostegia mollis* on East Maui; *Schiedea kaalae* in the Koolau Mountain range on Oahu; and *Tetramolopium lepidotum* spp. *lepidotum* on Hawaii.

The 31 plant taxa and their habitats have been adversely effected in various degrees by one or more of the following: trampling, predation, and habitat destruction by introduced ungulates; habitat degradation and competition for space, light, water, and nutrients by naturalized, alien vegetation; habitat loss from fires; insects and disease; predation by rodents and slugs; small number of individuals and populations; loss of pollinators; and introduced bird species. A few of these taxa may have been subjected to overcollection, primarily for scientific or horticultural purposes, and are subject to trampling by human beings along trails. Because of the depauperate number of extant individuals and severely restricted distributions, populations of these taxa are subject to an increased likelihood of extinction from stochastic events.

The land that supports these 31 plant taxa is owned by the State of Hawaii (including land classified as Department of Hawaiian Home Lands, Natural Area Reserves System, and Forest Reserve lands), the City and County of Honolulu, the Federal government, and private parties. Plants on federal land are located on portions of Schofield Barracks and Makua Military Reservation (both under the jurisdiction of the U.S. Army) and Lualualei Naval Magazine (under the jurisdiction of the U.S. Navy).

Part I of this plan has been constructed in a species-by-species format, allowing the reader to find all information about a particular species in one section, and allowing for efficient revision to include other Waianae taxa, and perhaps other island of Oahu taxa, as they are listed. Eventually this will produce one large, coordinated master plan for recovery of plant species in the Waianae Mountains, and possibly on the entire island of Oahu, including a comprehensive analysis of the threats to the Waianae ecosystems and species as a whole, and species-by-species analyses of recovery actions which are needed for stabilization and recovery. Species could then be grouped within ecosystem types, since several species within such groups of taxa could sometimes be benefited by a single recovery action. Multispecies projects should be developed to make this possible.

B. General Description of Habitat

The island of Oahu was formed from the remnants of two large shield volcanoes, the older Waianae Volcano on the west and the younger Koolau Volcano on the east (Figure 1). Their original shield volcano shape has been lost as a result of extensive erosion, and today these volcanoes are called "mountains" or "ranges," and consist of long, narrow ridges. The Waianae Mountains were built by eruptions that took place primarily along three rift zones. The two principal rift zones run in a northwestward and south-southeastward direction from the summit, and a lesser one runs to the northeast. The range is approximately 40 miles (64 kilometers) long. The caldera lies between the north side of Makaha Valley and the head of Nanakuli Valley (MacDonald *et al.* 1983). The Waianae Mountains are in the rain shadow of the parallel Koolau Mountains and except for Mt. Kaala, the highest point on Oahu (4020 feet (1,225 meters)), receive much less rainfall (Wagner *et al.* 1990). The median annual rainfall for the Waianae Mountains varies from 20 to 75 inches (51 to 191 centimeters), with only the small summit area of Mt. Kaala receiving the highest amount.

Appendix B summarizes the species associated with the Waianae Recovery Plan taxa and their habitat types. Appendix C provides a summary of land ownership/management for the Waianae Recovery Plan taxa. Appendix D contains illustrations of historic and current ranges of the Waianae Recovery Plan taxa.

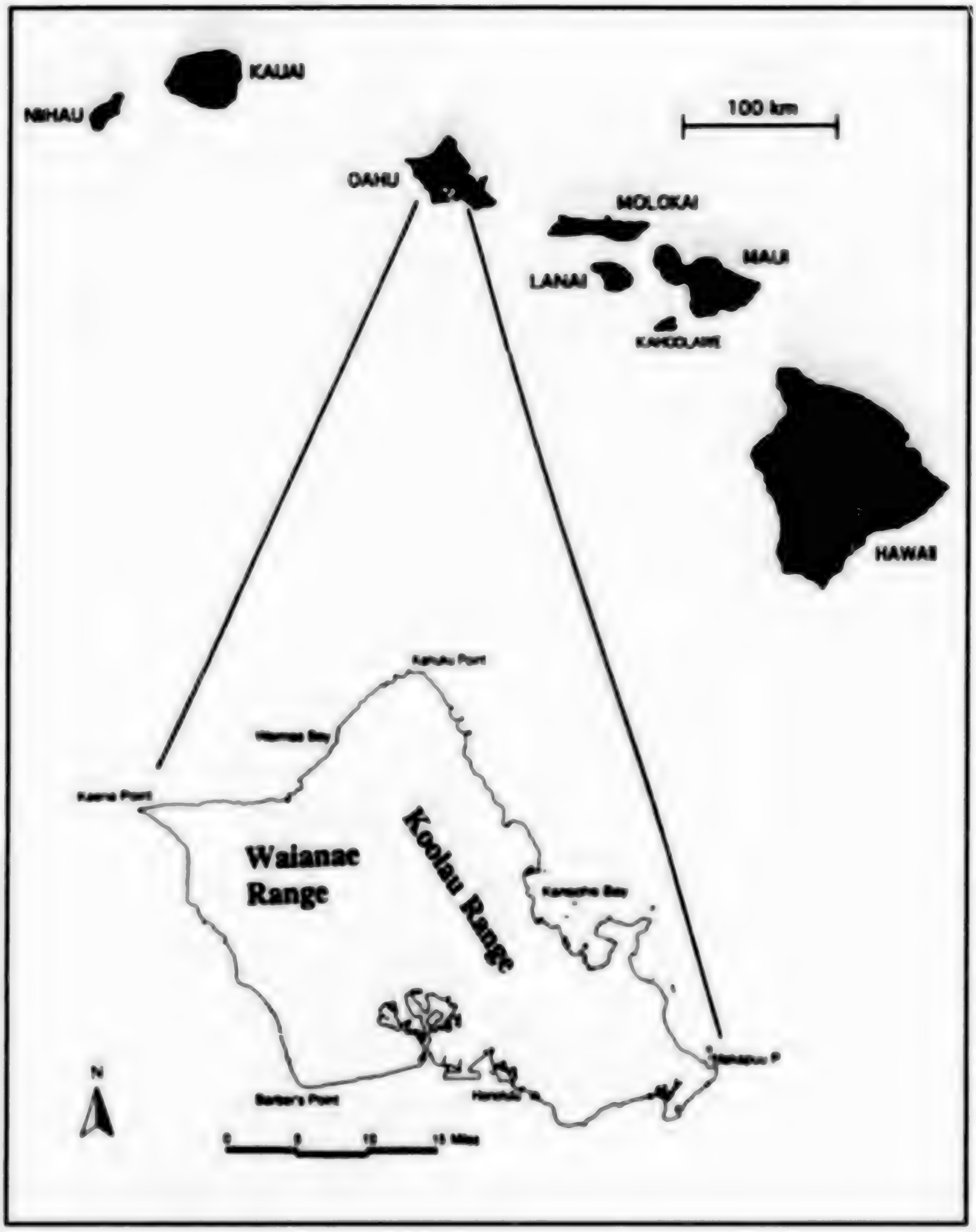

Figure 1. Waianae and Koolau Ranges on Oahu in relation to other islands in the Hawaiian chain.

C. Overall Reasons for Decline and Current Threats

Below is a general discussion of threats to the native communities upon which the taxa covered in this plan depend. Threats with the most significant impact and specific to each taxon are summarized in Table 1.

The native vegetation of the Waianae Mountains and adjacent areas has undergone extreme alterations because of past and present land management practices, including deliberate alien plant and animal introductions, agricultural development, and military use (Frierson 1973, Wagner *et al*. 1985). Degradation of habitat by introduced animals and competition with alien plants are considered the greatest present threats to the 31 taxa in this recovery plan.

1. Introduced ungulates

Feral pigs (*Sus scrofa*) have been in the Waianae Mountains for about 150 years and are known to be one of the major current modifiers of forest habitats (Stone 1985). Pigs damage the native vegetation by rooting and trampling the forest floor and encourage the expansion of alien plants that are better able to exploit the newly tilled soils than are native species (Stone 1985). Pigs also disseminate alien plant species through their feces and on their bodies, accelerating the spread of such species within the native forest. Present throughout the Waianae Mountains in low numbers, feral pigs pose a significant threat to the native flora (USFWS 1991b). For example, digging was noted in the wet summit forests within Honouliuli in the southern Waianae Mountains where two of the plant species (*Cyanea pinnatifida* and *Urera kaalae*) are restricted (USFWS 1991b). In Pahole Gulch in the northwestern Waianae Mountains, a population of pigs, which are thriving as the result of insufficient control, threatens at least two of the plant species in this recovery plan, *Alsinidendron trinerve* and *Schiedea kaalae* (Nagata 1980). Of the 31 plant taxa, 18 are threatened or already have sustained loss of individual plants or habitat as the result of feral pig activity (Nagata 1980; USFWS 1991b).

Although feral cattle (*Bos taurus*) were eliminated from Oahu by the mid-1900s (Stone 1985), the effects of cattle ranching have left an indelible scar on the native low to mid-elevation forests of the Waianae Mountains. Much of the forest between 700 and 1,800 feet (210 and 550 meters) in elevation has been destroyed by cattle and feral goats (*Capra hircus*) (Cuddihy and Stone 1990), effectively restricting the native vegetation to higher elevations (Nagata 1980). Cattle ranching still continues in the Mokuleia area on the west side of the Waianae Mountains. Taking advantage of the natural barrier of its slopes, ranchers have not installed adequate fences to contain the cattle. Some cattle escape into the upland forest (USFWS 1991b) where they consume native vegetation, trample roots and seedlings, accelerate erosion, and promote the invasion of alien plants (Scott *et al.* 1986). Species such as *Abutilon sandwicense*, *Diellia falcata*, and *Nototrichium humile* have been detrimentally affected by the activities of cattle (USFWS 1991b). Cattle grazing also is considered a threat to the population of *Centaurium sebaeoides* on Maui (USFWS 1991b).

Goats have been on Oahu for the past 170 years. Because of their commercial value in the 1820s, goats were allowed to proliferate throughout the Waianae Mountains without the confines of fences (Culliney 1988). As a result of their agility, goats were able to reach more remote areas than pigs or cattle. Goats (and cattle) are responsible for the destruction of most of the lower elevation dryland forests of Oahu (Stone 1985). The impact of feral goats on the native vegetation is similar to that described above for cattle (Scott *et al.* 1986). Successful control efforts decreased the goat population significantly by 1905 (Gill *et al.* 1989). They were thought to have been removed during the 1980's (Carolyn Corn, Hawaii Department of Land and Natural Resources (DLNR), personal communication 1995); however, their estimated numbers and ranges are increasing and there is a problem of trampling and grazing by goats in areas where 12 of the 26 plant taxa now occur (Culliney 1988). Erosion is a serious direct effect of grazing and trampling by feral goats. Through their activities, goats remove the ground cover, exposing the soil to erosional actions, thereby further degrading the habitat (USFWS 1991b). Encroaching urbanization and hunting pressure tend to

Table 1. Summary of threats to the Waianae Recovery Plan taxa.

Species	Alien Species	Fire	Disease/ Predation	Limited Numbers	Human Impacts
Abutilon sandwicense	C,P,G,PL	X	X		
Alsinidendron obovatum	P, PL			X	X
Alsinidendron trinerve	P, PL			X	X
Centaurium sebaeoides	C,G,PL	X			X
Chamaesyce celastroides var. kaenana	PL	X			X
Chamaesyce kuwaleana	PL	X		X	
Cyanea grimesiana ssp. obatae	PL, P		X	X	
Cyanea pinnatifida	P, PL			X	X
Cyanea superba	PL, P	X		X	X
Diellia falcata	P,C,G,PL	X			
Diellia unisora	PL, P				
Dubautia herbstobatae	P, G, PL	X		X	X
Gouania meyenii	P, PL	X		X	
Gouania vitifolia	P, PL		X	X	
Hedyotis degeneri	P, PL			X	
Hedyotis parvula	G,P,PL			X	
Hesperomannia arbuscula	P, PL			X	X
Lipochaeta lobata var. leptophylla	G,PL	X		X	
Lipochaeta tenuifolia	P, G, PL	X			
Lobelia niihauensis	P, G, PL	X	X		X
Neraudia angulata	P, G, PL	X		X	
Nototrichium humile	P,C,G,PL	X			
Phyllostegia mollis	P,PL			X	
Sanicula mariversa	G, PL	X		X	X
Schiedea kaalae	P, G, PL	X		X	
Silene perlmanii	P,PL			X	
Stenogyne kanehoana	P,PL	X		X	X
Tetramolopium filiforme	G, PL	X			X
Tetramolopium lepidotum spp. lepidotum	G,S,P,PL	X		X	X
Urera kaalae	P, PL	X		X	
Viola chamissoniana spp. chamissoniana	G,P,PL	X		X	
Total Number of Species Affected	*31	20	4	22	13

*(Pigs - 25; Cattle - 4; Goats - 15; Sheep - 1; Plants - 31)

Key: P - Pigs, C - Cattle, G - Goats, S - Sheep, PL - Plants restrict goats to the drier upper slopes of the Waianae Mountains (Tomich 1986). The dry to mesic habitat of *Diellia falcata*, *Dubautia herbstobatae*, *Hedyotis parvula*, *Lipochaeta tenuifolia*, *Lobelia niihauensis*, *Neraudia angulata*, *Nototrichium humile*, *Sanicula mariversa*, *Schiedea kaalae*, *Tetramolopium filiforme*, and *Viola chamissoniana* ssp. *chamissoniana* in the Waianae Mountains is being heavily degraded by these animals (USFWS 1991b).

Habitat degradation by goats, cattle, sheep, deer, or pigs is a likely threat to the populations of the eight plant taxa whose distributions extend beyond the Waianae Mountains to elsewhere on Oahu, Hawaii, Kauai, Lanai, Molokai, or Maui (*Centaurium sebaeoides*, *Gouania meyenii*, *Hesperomannia arbuscula*, *Lobelia niihauensis*, *Nototrichium humile*, *Phyllostegia mollis*, *Schiedea kaalae*, and *Tetramolopium lepidotum* spp. *lepidotum*). The adverse impacts of these animals on these eight plant taxa are similar to the effects observed in the Waianae Mountains.

2. Competition from Alien Plant Species

All 31 taxa in this recovery plan are threatened by competition from one or more alien plant species. *Schinus terebinthifolius* (Christmasberry), introduced to Hawaii before 1911 as an ornamental tree, has had particularly detrimental impacts (Cuddihy and Stone 1990). This fast-growing alien plant is able to form dense thickets, displacing other plants; it also may release a chemical that inhibits the growth of other species (Smith 1985). As early as the 1940s, Christmasberry had invaded the dry slopes of Oahu; it is now replacing the native vegetation of much of the southern Waianae Mountains (Cuddihy and Stone 1990). Christmasberry is gradually invading other areas of the Waianae Mountains as well, and now is found on nearly all of the other Hawaiian Islands. It now threatens to occupy the habitat of 20 of the 31 plants in this recovery plan (USFWS 1991b).

The native vegetation of the leeward ridges of the Waianae Mountains, especially Ohikilolo, Kamaileunu, and Kumaipo ridges, is being replaced by *Melinus minutiflora* (molasses grass), another aggressive alien plant species. This species and Christmasberry are considered the two most serious alien plant problems in these areas (USFWS 1991b). Molasses grass ranges from the dry lowlands to the lower wet forests, especially in open areas with sparse vegetation, and is distributed on the other islands as well. This fire-adapted grass produces a dense mat capable of smothering plants, provides fuel for fires, and carries fires into areas with native woody plants (Cuddihy and Stone 1990). Because most native forest species are not fire-adapted, molasses grass is able to exploit freshly burned areas (USFWS 1991b). Populations of 19 of the 26 endangered taxa located on leeward slopes and ridges are most vulnerable to molasses grass (USFWS 1991b).

Myrica faya (firetree), a species that was introduced before 1900 as an ornamental or for firewood, inhabits dry to mesic habitats on most of the Hawaiian Islands (Cuddihy and Stone 1990). The Territory of Hawaii planted firetree in the Waianae Mountains in the 1920s for reforestation. It is known to occur in the northern Waianae Mountains in Makua Valley and also forms a dense stand near Palikea in the Honouliuli Preserve and has spread approximately 2 miles (3 kilometers) to the north (Whiteaker and Gardner 1985) where it poses a threat to the habitat of *Schiedea kaalae*, *Silene perlmanii*, *Tetramolopium lepidotum* ssp. *lepidotum*, and *Urera kaalae*. The impact of this noxious tree is serious because, given suitable habitat, firetree can form a dense, closed canopy to the exclusion or detriment of other plants. This plant also fixes nitrogen, making it adaptable to habitats with low nitrogen soils and an excellent competitor with native plants that have evolved in low nitrogen conditions (Cuddihy and Stone 1990).

Psidium cattleianum (strawberry guava), a pervasive alien tree in the Waianae Mountains, is distributed by feral pigs, fruit-eating birds, and humans (Smith 1985). It also is found on the other Hawaiian Islands. Like Christmasberry and firetree, strawberry guava forms dense stands to the exclusion of other plant species (Cuddihy and Stone 1990). Populations of *Diellia falcata*, *Gouania meyenii*, *Hedyotis degeneri*, *Hesperomannia arbuscula*, *Lipochaeta tenuifolia*, *Neraudia angulata*, *Nototrichium humile*, and *Urera kaalae* are immediately threatened by competition with this alien plant (Obata 1986, USFWS 1991b).

Leucaena leucocephala (koa haole) is an alien tree usually seen in disturbed lowland areas on the Hawaiian Islands. Originally introduced as fodder (Smith 1989), it is now widely distributed in dry and mesic forests that are the habitat for *Centaurium sebaeoides*, *Chamaesyce celastroides* var. *kaenana*, *Chamaesyce kuwaleana*, *Dubautia herbstobatae*, *Lipochaeta lobata* var. *leptophylla*, *Lipochaeta tenuifolia*, *Lobelia niihauensis*, *Nototrichium humile*, and *Tetramolopium filiforme* (USFWS 1991b). Like firetree, koa haole is an aggressive competitor that fixes nitrogen.

Clidemia hirta (Koster's curse), a noxious shrub first cultivated in Wahiawa on Oahu, spread to the Koolau Mountains in the early 1960s, where it is now rapidly displacing native vegetation. Koster's curse spread to the Waianae Mountains around 1970 and is now widespread throughout Honouliuli (Cuddihy and Stone 1990, Culliney 1988). It recently has been found on other Hawaiian Islands (Cuddihy and Stone 1990). This species forms a dense understory, shading other plants and hindering plant regeneration (USFWS 1991b). At present, Koster's curse threatens to replace four of the plant species included in this recovery plan: *Abutilon sandwicense*, *Cyanea pinnatifida*, and *Hesperomannia arbuscula* in the Waianae Mountains and *Schiedea kaalae* in the Koolau Mountains (USFWS 1991b).

Rubus argutus (blackberry), recognized as a noxious weed by the Hawaii State Department of Agriculture (Cuddihy and Stone 1990), poses a serious threat to *Alsinidendron trinerve* and *Hesperomannia arbuscula* (USFWS 1991b). Blackberry occurs in the Waianae Mountains between 3,300 and 7,500 feet (1,000 and 2,300 meters) in elevation, where it forms impenetrable thickets in disturbed areas (Smith 1985). Its distribution includes most of the Hawaiian Islands.

Passiflora suberosa (huehue haole), a vine that smothers small plants in the subcanopy of dryland habitats (Smith 1985) on Oahu, Maui, and Hawaii, poses an immediate threat to several of the plant species in this recovery plan. There are major infestations in the Waianae Mountains and it is a probable threat to all extant populations of *Urera kaalae* and to some populations of *Abutilon sandwicense* and *Diellia falcata* (USFWS 1991b).

Erigeron karvinskianus (daisy fleabane) is another low-growing alien species that smothers native plants, particularly on cliffs, and is found on most of the Hawaiian Islands. This species threatens *Cyanea pinnatifida*, *Lobelia niihauensis*, *Tetramolopium filiforme*, and *Tetramolopium lepidotum* ssp. *lepidotum* (USFWS 1991b).

3. Fire

Fire threatens 18 of the 31 taxa in this recovery plan, particularly those located upslope from Makua Military Reservation and Schofield Barracks, where current firing exercises could unintentionally ignite fires. Within a 14-month period in 1989 and 1990, for example, a total of 10 fires resulted from firing activities in the Makua Military Reservation. Of these, eight occurred outside of the firebreak installed by the Army. A 300 acre (120 hectare) fire in July 1989 may have destroyed a population of *Neraudia angulata*, and came within 0.25 miles (0.4 kilometers) of a population of *Nototrichium humile*. Although most fires have been contained within 0.02 acres (0.01 hectares), the July 1989 fire is evidence of the potential for escape into the fire-prone habitat of 18 of the taxa in this recovery plan (*Abutilon sandwicense*, *Centaurium sebaeoides*, *Chamaesyce celastroides* var. *kaenana*, *Chamaesyce kuwaleana*, *Cyanea superba*, *Diellia falcata*, *Dubautia herbstobatae*, *Gouania meyenii*, *Lipochaeta lobata* var. *leptophylla*, *Lipochaeta tenuifolia*, *Lobelia niihauensis*, *Neraudia angulata*, *Nototrichium humile*, *Sanicula mariversa*, *Schiedea kaalae*, *Stenogyne kanehoana*, *Tetramolopium filiforme*, and *Urera kaalae*) (Carr 1982, St. John 1981b, USFWS 1991b).

Fire is a potential threat on the Naval Magazine lands at Lualualei. If the Navy could not control a fire, it could burn all the way up to the ridge, possibly effecting six of the taxa in this recovery plan (*Chamaesyce kuwaleana*, *Lipochaeta lobata* var. *leptophylla*, *Phyllostegia mollis*, *Schiedea kaalae*, *Silene perlmanii*, and *Tetramolopium lepidotum* ssp. *lepidotum*).

Fire is also a threat on the southeast and southwest sides of the Waianae Mountains. Arson and agricultural fires have burned up to 1,600 feet (485 meters) elevation in recent years. Arson fires occur regularly all along the Waianae Coast, including some significant areas burned just north of the Makua Military Reservation (Barrie Morgan, The Nature Conservancy of Hawaii (TNC), personal communication 1995).

4. Illegal Collecting and Other Human Impacts

Illegal collecting for scientific, educational, or horticultural purposes or excessive visits by individuals interested in seeing rare plants could result from increased publicity, and would seriously impact several of these taxa. *Alsinidendron obovatum*, *Alsinidendron trinerve*, *Centaurium sebaeoides*, *Chamaesyce celastroides* var. *kaenana*, *Cyanea pinnatifida*, *Cyanea superba*, *Dubautia herbstobatae*, *Hesperomannia arbuscula*, *Lobelia niihauensis*, *Sanicula mariversa*, *Stenogyne kanehoana*, *Tetramolopium filiforme*, and *Tetramolopium lepidotum* ssp. *lepidotum* are located on or near trails or roads and have the potential of being collected or trampled (Nagata 1980, USFWS 1991b). For these 13 taxa, disturbance from trampling during recreational use (hiking, for example) could promote erosion and greater ingress by competing alien species.

5. Insects and Disease

Xylosandrus compactus (black twig borer) has been cited as a possible threat to the extant populations of *Urera kaalae* (St. John 1981b) and *Abutilon sandwicense* (Joel Lau, TNC, personal communication 1995). The black twig borer burrows into the branches and introduces a pathogenic fungus, pruning the host severely, often killing branches or whole plants (Hara and Beardsley 1979, Howarth 1985).

Sophonia rufofascia (two-spotted leafhopper) is a potential threat to the Waianae Recovery Plan taxa and the surrounding ecosystem. It was introduced to Hawaii in the late 1980's and has been found on all of the major Hawaiian Islands, including within the Waianae Mountain Range. The two-spotted leafhopper injects toxins while feeding which causes yellowing and wilting within the feeding area on a plant (Adam Asquith, USFWS, personal communication 1995). It appears to feed on almost all species, native and introduced, in the Waianae Mountains (Marie Bruegmann, USFWS, personal communication 1995).

6. Predation

Rats and slugs have been cited as probable threats to the Waianae Recovery Plan taxa because they eat the fruits and seeds, and chew on the stems, foliage, and seedlings (Center for Plant Conservation 1990, Wagner *et al*. 1985, USFWS 1994; J. Lau, personal communication 1995).

Slugs are also suspected to threaten several of the Waianae Recovery Plan taxa at the seedling stage (Steve Weller, U.C. Irvine, personal communication 1995; Bill Garnett, DLNR, personal communication 1995).

7. Small Number of Populations and Individual Plants

The small number of populations and individual plants of all of these taxa increases the potential for extinction from stochastic events. The limited gene pool may depress reproductive vigor, or a single man-caused or natural environmental disturbance could destroy a significant percentage of the individuals (or the only known extant population) of these taxa. For example, 3 of the taxa are known from a single population: *Cyanea pinnatifida* (totaling 1 known plant), *Gouania vitifolia* (5 plants), and *Stenogyne kanehoana* (2 plants) (USFWS 1991b, 1992, 1994). Sixteen of the 31 taxa are known from fewer than 5 populations and 15 of the taxa are estimated to number no more than 100 known individuals.

8. Loss of Pollinators

Loss of pollinators is a possible threat to many of the Waianae Recovery Plan taxa because many native birds and insects, which may have acted as their pollinators, have become extinct or have declined drastically. Research to determine the presence/absence and nature of appropriate pollinators for each of the Waianae Recovery Plan taxa will be essential to their recovery.

9. Introduced Bird Species.

Introduced birds may threaten some or all of the Waianae Recovery Plan taxa through their spread of alien plant seeds. They have also contributed to the loss of native bird pollinators for some of the Waianae Recovery Plan taxa, through competition and the introduction of disease.

D. Overall Conservation Efforts

1. Federal Actions

The 31 taxa in this recovery plan were listed as endangered, without the designation of critical habitat, under the Act on September 11, 1991 (USFWS 1991a), October 29, 1991 (USFWS 1991b), May 13, 1992 (USFWS 1992), and June 27, 1994 (USFWS 1994), and therefore, are afforded the protection of this Act. Critical habitat was not deemed prudent because of the possible increased threat to the plants by vandalism, researchers, curiosity seekers, or collectors of rare plants due to the mandated publication of precise maps and descriptions of critical habitat in local newspapers.

Some of the plant taxa in this plan are located on the Makua Military Reservation and Schofield Barracks, both under the jurisdiction of the U.S. Army. The military uses portions of both these areas for ordnance training of its troops and provides a buffer zone adjacent to the impact areas. Entry into the buffer area, by personnel, is forbidden to prevent injury from stray or unexploded shells or other devices (USFWS 1991b). Virtually all of the listed plants that occur on Army land are present only in the buffer zones and, therefore, are not directly affected by military activities. In compliance with its fire plan, the Army has constructed firebreaks on the Makua Military Reservation to minimize damage from unintentional fires that occasionally result from stray bullets (USFWS 1991b).

The military also contracted The Nature Conservancy of Hawaii to prepare complete biological inventories of Schofield Barracks and Makua Military Reservations. These inventories are being used to assist in the management of the natural resources on Department of Defense lands.

2. State Actions

The 31 taxa in this recovery plan are listed as endangered by the State of Hawaii (Hawaii Revised Statutes Chapter [HRS] 195D). Hawaii State law prohibits taking of endangered flora and encourages conservation by State government agencies. ("Take" as defined by Hawaii State law means "to harass, harm..., wound, kill..., or collect endangered or threatened...species...or to cut, collect, uproot, destroy, injure, or possess endangered or threatened...species of...land plants, or to attempt to engage in any such conduct" [HRS 195D]). Because of their protection under the State laws of Hawaii, the Act offers additional Federal protection to these taxa, since it is a violation of the Act for any person to remove, cut, dig up, or damage or destroy an endangered plant in an area not under Federal jurisdiction in knowing violation of any State law or regulation or in the course of any violation of a State criminal trespass law [section 9(a)(2) of the Act].

The primary management, by the State of Hawaii, of the Waianae Recovery Plan taxa includes the protection of the Waianae range from fire and feral ungulates. Some weeding of alien plant species occurs in the Natural Area Reserves (NAR)s (Mt. Kaala and Pahole) and the State assists in the collection of seeds for the propagation of several of the Waianae Recovery Plan taxa (Randy Kennedy, DLNR, personal communication 1994).

The State of Hawaii has also conducted some outplantings of the Waianae taxa. *Cyanea superba* and *Alsinidendron trinerve* have been planted in Pahole NAR and *Camaesyce calastroides* var. *kaenana* has been planted in Kaena NAR (Julie Reyes, DLNR, personal communication 1995).

3. City and County and Nongovernmental Actions

Seeds and/or plants of some of the Waianae Recovery Plan taxa have been collected by National Tropical Botanical Garden, Lawai, Kauai (NTBG) and the Harold L. Lyon Arboretum, University of Hawaii at Manoa (Lyon Arboretum). Many of these have also been successfully propagated in their facilities. Tables 2, 3, and 4, present NTBG, Lyon Arboretum, and Waimea Arboretum's seed holdings and propagation success as of August 1994, January 1995, and February 1995, respectively. NTBG's plans for these holdings include research into propagation methods and feasibility of long-term seed storage (Diane Ragone, NTBG, personal communication 1994).

Taxon	**Seeds**	**Propagated**
Abutilon sandwicense	233	Y
Alsinidendron obovatum	10,002	Y
Alsinidendron trinerve	1,852	Y
Centaurium sebaeoides	100	N
Chamaesyce celastroides var. *kaenana*	0	Y
Chamaesyce kuwaleana	2	Y
Cyanea grimesiana ssp. *obatae*	9,102	Y
Cyanea pinnatifida	0	N
Cyanea superba	4	Y
Diellia falcata	0	N
Diellia unisora	0	Y
Dubautia herbstobatae	2	N
Gouania meyenii	13	Y
Gouania vitifolia	0	Y
Hedyotis degeneri	1,250	N
Hedyotis parvula	1,202	Y
Hesperomannia arbuscula	700	Y
Lipochaeta lobata var. *leptophylla*	100	Y
Lipochaeta tenuifolia	129	Y
Lobelia niihauensis	302+	Y
Neraudia angulata	99	Y
Nototrichium humile	3,602+	N
Phyllostegia mollis	0	Y
Sanicula mariversa	237	Y
Schiedea kaalae	0	Y
Silene perlmanii	2	Y
Stenogyne kanehoana	0	N
Tetramolopium filiforme	1,452+	N
Tetramolopium lepidotum spp. *lepidotum*	884	Y
Urera kaalae	5,527+	N
Viola chamissoniana spp. *chamissoniana*	100	Y

Table 2. Seeds and plants of the Waianae Recovery Plan taxa at the National Tropical Botanical Garden, Kauai (D. Ragone, personal communication 1994).

Taxon	Seedlines(Seeds)	Propagated	Growing/ Reprod
Abutilon sandwicense		Y	Y
Alsinidendron trinerve	95(372)	Y	Y
Cyanea grimesiana ssp. *obatae*	342(458)	Y	
Cyanea pinnatifida	1(307)	Y	
Cyanea superba	1,000(1,000)	Y	Y
Hedyotis parvula	28(1,984)	Y	
Lipochaeta lobata var. *leptophylla*	0	Y	Y
Lipochaeta tenuifolia	0	Y	Y
Lobelia niihauensis	26(26)	Y	
Phyllostegia mollis	0	Y	
Schiedea kaalae	1(20)	Y	Y
Silene perlmanii	29(158)	Y	Y
Stenogyne kanehoana	1(2)	Y	
Tetramolopium filiforme	87(87)	N	

Table 3. Seeds and plants of the Waianae Recovery Plan taxa at the Lyon Arboretum (Greg Koob and Karen Shigematsu, Lyon Arboretum, personal communication 1995).

Taxon	Seeds	Propagated	Growing/ Reprod
Abutilon sandwicense	30	Y	Y(6)
Alsinidendron trinerve	0	Y	Y(3)
Nototrichium humile	0	Y	Y(2)
Schiedea kaalae	0	Y	Y(13)
Urera kaalae	0	Y	Y(1)

Table 4. Seeds and plants of the Waianae Recovery Plan taxa at the Waimea Arboretum (Josephine Llop, Waimea Arboretum, personal communication 1995).

Research on some of the threats to the Waianae Recovery Plan taxa is being conducted by the University of Hawaii. The Nature Conservancy of Hawaii manages most of the Campbell Estate property within the range of the Waianae Recovery Plan taxa.

E. Species Accounts

1. *Abutilon sandwicense* - Recovery Priority # (RP#) - 8 (on USFWS 1-18 scale, Appendix G)

a. Description and Taxonomy

Appendix E contains a line drawing of *Abutilon sandwicense*

In 1932, Otto Degener (1932a, 1932b) discovered and described what is now called *Abutilon sandwicense*, naming it *Abortopetalum sandwicense* for the Sandwich Islands, an earlier name for the Hawaiian Islands. Degener's new genus, *Abortopetalum*, was based primarily on its spatula-shaped, "abortive" petals. Erling Christophersen (1934) transferred the species to the genus *Abutilon* because none of the characters of the genus *Abortopetalum* made it distinctive from the generally accepted definition of *Abutilon*. In the same publication, Christophersen described variety *welchii* from Lualualei Valley, but the most recent treatment of the genus (Bates 1990) considers the differences cited by Christophersen to be within the normal range of variation of this species.

Abutilon sandwicense, of the mallow family (Malvaceae), is a shrub that grows to 10 feet (3 meters) tall and is covered with short glandular hairs. Leaves are light green, heart-shaped, and 3 to 9 inches (8 to 22 centimeters) long. A single pendulous flower grows from the leaf axil (the point between the leaf and the stem). The flowers have pale, greenish-yellow, hairy, glandular sepals and bright green, often reddish-brown tipped petals up to 2 inches (5 centimeters) long. A greenish-yellow staminal column with about 350 stamens near its tip protrudes from the flower. The fruit is a capsule up to 1 inch (2.5 centimeters) long, which breaks into 8 to 10 parts, each enclosing 3 or more seeds. Seeds are brown, up to 0.1 inches (3 millimeters) long, and slightly hairy. This species is distinguished from others in the genus by the green or reddish-brown tipped petals which extend beyond the sepals (USFWS 1991b).

b. Life History

Abutilon sandwicense has been observed flowering in winter and spring. By summer, most plants have flowered and the fruits have usually dried up by fall. Fruit capsules develop within 6 weeks. Although seedlings are often initially abundant, few plants appear to survive to maturity for unknown reasons (John Obata, personal communication 1995).

c. Habitat Description

Abutilon sandwicense typically grows on steep slopes or gulches in dry to mesic lowland forest at an elevation of 1,000 to 2,000 feet (300 to 600 meters) (USFWS 1991b). Associated species include *Aleurites moluccana* (kukui), *Caesalpinia kavaiensis* (uhiuhi), *Diospyros* (lama), *Sapindus oahuensis* (aulu), and *Schinus terebinthifolius* (Christmasberry) (USFWS 1991b).

d. Historic and Current Range and Population Status

Historically, *Abutilon sandwicense* is known from nearly the entire length of the Waianae Mountains, from Makaleha Valley to Nanakuli Valley (Bates 1990). This species is now known from Makaleha Valley east to Palikea Gulch, south to Nanakuli Valley, and Makaha-Waianae Kai Ridge on State, Federal, City/County, and privately-owned land (Hawaii Heritage Program (HHP) 1994a, 1994c). The 12 known populations, which are found in an area of about 5 by 10 miles (8 by 16 kilometers), contain an estimated 280 to 290 individuals (HHP 1994a, 1994c).

e. Reasons for Decline and Current Threats

The major threats to *Abutilon sandwicense* are competition from alien plant species (Christmasberry, *Clidemia hirta* (Koster's curse), *Melinus minutiflora* (molasses grass), and *Passiflora suberosa* (huehue haole)), fire, and trampling by goats, pigs, and cattle (USFWS 1991b; Steve Perlman, NTBG, personal communication 1995). Cultivated plants of *A. sandwicense* are also affected by the black twig borer (J. Lau, personal communication 1995).

f. Conservation Measures

TNC is monitoring and controlling alien weeds around one population of *Abutilon sandwicense* in Honouliuli Preserve at Huliwai Gulch. The 11 plants in this population appear to be healthy, but they are threatened by *Passiflora suberosa* as well as human activity on an adjacent trail (Jennifer Crummer, TNC, personal communication 1995).

Abutilon sandwicense is targeted for outplanting by DLNR at Pahole NAR (B. Garnett, personal communication 1995).

g. Needed Recovery Actions

Below is a suggested species-specific recovery action. This action does not reflect the order in which it should be accomplished or take priority over any other recovery tasks. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

1) Survey likely areas for additional populations and implement protective measures if necessary.

Additional populations or individuals are likely to be found with additional searching, especially in areas around Puu Pane (S. Perlman, personal communication 1995).

2. **Alsinidendron obovatum** - RP# 5

a. Description and Taxonomy

Appendix E contains a line drawing of *Alsinidendron obovatum*.

Earl Edward Sherff (1951) first described *Alsinidendron obovatum* based on specimens collected by Charles Noyes Forbes in 1911, choosing a specific epithet describing the shape of the leaves. In the same publication (Sherff 1951), Degener and Sherff described var. *parvifolium* based on its small leaves. The most recent treatment of the genus (Wagner *et al*. 1990) does not recognize any varieties in this taxon.

Alsinidendron obovatum, a member of the pink family (Caryophyllaceae), is a branching subshrub growing to 3 feet (1 meter) tall. The leaves are thick, somewhat fleshy, elliptic shaped, 1.6 to 4.3 inches (4 to 11 centimeters) long, and up to 2.4 inches (6 centimeters) wide, with 3 or 5 large veins. The inflorescence comprises 7 to 12 flowers arranged in a congested cluster. The flowers lack petals, but usually have 5 sepals which are white inside and green or green-veined on the outside (USFWS 1991b). In fruit, the sepals become fleshy and purple and enclose the capsule, forming a structure similar to a berry in appearance and perhaps attractive to birds, which would aid in dispersal. Seeds are black and about 0.04 inches (1 millimeter) long. This species and *Alsinidendron trinerve* can be distinguished from other members of the genus by their shrubby habit and fleshy purple sepals surrounding the capsule (USFWS 1991b).

b. Life History

Alsinidendron obovatum generally flowers after about two years of growth. Plants flower and fruit year round, but flowering is usually heavier in winter and spring depending on the level of precipitation. Plants survive three to six years, unless there are drought conditions (J. Obata, personal communication 1995).

c. Habitat Description

Alsinidendron obovatum typically grows on ridges and slopes in lowland diverse mesic forest dominated by *Acacia koa* (koa) and *Metrosideros polymorpha* ('ohi'a) at an elevation of 1,850 to 2,500 feet (560 to 760 meters) (USFWS 1991b, Wagner *et al.* 1990). Associated species include *Bidens* (ko'oko'olau) and *Syzygium cumini* (Java plum) (USFWS 1991b).

d. Historic and Current Range and Population Status

Historically, *Alsinidendron obovatum* is known from the northern and southern ends of the Waianae range (Wagner et al. 1990). This species remains in Kapuna and Pahole gulches on State-owned land (HHP 1994a, 1994b). The 3 known populations, which are about 1.0 mile (1.6 kilometers) apart, contain about 11 individuals (J. Lau, personal communication 1995).

e. Reasons for Decline and Current Threats

The major threats to *Alsinidendron obovatum* are competition from the aggressive alien plant species, molasses grass; habitat degradation by feral pigs; collection or trampling by humans; and the small number of populations (USFWS 1991b).

f. Conservation Measures

Alsinidendron obovatum is targeted for outplanting by DLNR at Pahole NAR. There is 1 individual growing at the mid-elevation nursery at the Nike site (B. Garnett, personal communication 1995).

g. Needed Recovery Actions

There are no known species-specific recovery actions for this species at this time. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

3. *Alsinidendron trinerve* - RP# 5

a. Description and Taxonomy

Appendix E contains a line drawing of *Alsinidendron trinerve*.

Alsinidendron trinerve was first collected by Louis Charles Adelbert von Chamisso in 1816 or 1823 (Kimura and Nagata 1980). Horace Mann, Jr. (1866) described the genus *Alsinidendron* based on a specimen he collected with William Tufts Brigham. As it is a shrub related to and resembling chickweed, he named it after the Greek for chickweed (*alsine*) and tree (*dendron*). The specific epithet refers to the three-veined leaves. Wilhelm Hillebrand (1888) amended the description of the genus to include information about the floral structures he called "staminodia," although they currently are believed to more likely represent nectaries or vestigial petals (Wagner *et al.* 1990). Ferdinand Pax and K. Hoffman (1934) transferred the species to *Schiedea*, a course not followed by other botanists who have studied the taxon.

Alsinidendron trinerve is very similar in appearance to *A. obovatum* but differs in that it has a more open inflorescence with peduncles more than 0.8 inches (2 centimeters) long, sepals with an acute tip, and usually is found in wet forests above 3,000 feet (900 meters) in elevation. *Alsinidendron obovatum* has a congested inflorescence with peduncles less than 0.8 inches (2 centimeters) long, sepals with a rounded tip, and usually grows in mesic forests 1,800 to 2,600 feet (550 to 800 meters) in elevation (USFWS 1991b).

b. Life History

Alsinidendron trinerve flowers and fruits throughout the year with the possible exception of fall (J. Obata, personal communication 1995).

c. Habitat Description

Alsinidendron trinerve typically grows on slopes in wet forest or the wetter portions of diverse mesic forest dominated by 'ohi'a and *Ilex anomala* (kawa'u) at an elevation of 3,000 to 4,000 feet (900 to 1,200 meters) (USFWS 1991b). Associated species include *Coprosma ochracea* (pilo), *Gunnera* ('ape'ape), *Melicope sandwicensis* (alani), and *Pipturus albidus* (mamaki) (USFWS 1991b).

d. Historic and Current Range and Population Status

Historically, *Alsinidendron trinerve* is known from the north-central and southern Waianae Mountains. This species is known to be extant on Mt. Kaala and Mt. Kalena on federally owned land (HHP 1994a, 1994c). The two populations on federal land, which are about 1 mile (1.6 kilometers) apart, contain about 32 individuals (HHP 1994a, 1994c).

e. Reasons for Decline and Current Threats

The major threats to *Alsinidendron trinerve* are competition from the aggressive alien plant species, *Rubus argutus* (blackberry); habitat degradation by feral pigs; trampling or collection by humans along trails; and the small number of extant individuals (USFWS 1991b).

f. Conservation Measures

TNC examined the Mt. Kaala population of *Alsinidendron trinerve* to determine management needs. Although the plants are threatened by feral pigs, TNC determined that a small fence around the population would increase open trampled areas that attract pigs and create sites for weeds to become established (J. Crummer, personal communication 1995).

Alsinidendron trinerve has been outplanted in Pahole and is targeted for outplanting by DLNR, possibly at Mt. Kaala or Schofield Barracks. There are 40 seedlings growing at the mid-elevation nursery at the Nike site (B. Garnett, personal communication 1995; J. Reyes, personal communication 1995).

g. Needed Recovery Actions

Below are some suggested species-specific recovery actions. These actions do not reflect the order in which they should be accomplished or take priority over any other recovery tasks, unless indicated. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

1) Control feral pigs.

Fencing of individual populations is not feasible at either of the extant populations because of the steep slopes (S. Perlman, personal communication 1995). Strategic fencing of a larger area should be considered and general feral pig control measures need to be implemented (J. Crummer, personal communication 1995).

2) Monitor extant populations and control alien weed threats, especially blackberry.

Manual removal of blackberry will be difficult at both sites and may harm populations by opening corridors for feral pigs. Any weeding should be done with care and biocontrol options need to be explored.

4. ***Centaurium sebaeoides* - RP# 2**

a. Description and Taxonomy

Appendix E contains a line drawing of *Centaurium sebaeoides*.

On the basis of a collection of specimens by Berthold Carl Seeman of what is now called *Centaurium sebaeoides*, August Grisebach (1853) named a new genus of plants, *Schenkia*, and gave it the specific epithet of *sebaeoides*, indicating its resemblance to a species of *Sebaea*, another genus in the gentian family. The taxon was transferred to the genus *Erythraea* in 1862 by Asa Gray (1862), and later by G. Claridge Druce (1917) to the genus *Centaurium*.

Centaurium sebaeoides is the only species of the gentian family (Gentianaceae) native to the Hawaiian Islands. It is an annual herb about 2.4 to 8 inches (6 to 20 centimeters) tall. Leaves are rather fleshy, inversely ovate or elliptic, and 0.3 to 1.3 inches (0.7 to 3.2 centimeters) long by less than 1 inch (2 centimeters) wide. Flowers are stalkless and are arranged along the stems near their ends. The fused sepals are 0.3 inches (8 millimeters) long and are divided into uneven lobes. The white or pale pink petals are fused into a tube up to 0.4 inches (10 millimeters) long, with lobes up to 0.2 inches (4.5 millimeters) long. The cylindrical capsules are up to 0.4 inches (9.5 millimeters) long and contain numerous tiny brown seeds. This species is distinguished from *C. erythraea*, which is naturalized in Hawaii, by its fleshy leaves and the unbranched arrangement of the flower cluster (USFWS 1991b, Wagner *et al*. 1990).

b. Life History

Centaurium sebaeoides has been observed flowering in April. Flowering may be induced by heavy rainfall. Populations are found in dry areas, and plants are more likely to be found following heavy rains (J. Obata, personal communication 1995).

c. Habitat Description

Centaurium sebaeoides typically grows in volcanic or clay soils or on cliffs in arid coastal areas below 400 feet (120 meters) elevation (USFWS 1991b, Wagner *et al.* 1990). Associated species include ko'oko'olau and *Lipochaeta* (nehe) (USFWS 1991b).

d. Historic and Current Range and Population Status

Historically, *Centaurium sebaeoides* is known from scattered localities on State and private land on the islands of Kauai, Oahu, Molokai, and Maui (Wagner *et al.* 1990). This species remains on State and private land in Awaawapuhi Valley, Kalalau Beach, and Pohakuao seacliffs on Kauai, at Kaena Point (possibly) and on the slopes above Halona Point on Oahu, near Mokio Point on Molokai, Maunalei Valley on Lanai, and on West Maui (HHP 1994a, Robert Hobdy, DLNR, personal communication 1995). Three known populations, about 4 miles (6 kilometers) apart, remain on Kauai. West Maui has one population between Waihee and Makamakaole and another population of one individual at Makamakaole, about 2 miles (3.2 kilometers) apart. Oahu has one population consisting of one individual. Molokai has one population with one individual. Lanai has one population with approximately five individuals. These eight populations contain fewer than an estimated 80-110 plants (HHP 1994a).

e. Reasons for Decline and Current Threats

The major threats to *Centaurium sebaeoides* are habitat degradation by feral goats and cattle; competition from the alien plant species, *Leucaena leucocephala* (koa haole); trampling by humans on or near trails; and fire. The threats are believed to be similar on Kauai, Oahu, Molokai, and West Maui (USFWS 1991b).

f. Conservation Measures

No specific conservation measures are being conducted for *Centaurium sebaeoides* except those mentioned in the Overall Conservation Efforts section of this plan.

g. Needed Recovery Actions

Below are some suggested species-specific recovery actions. These actions do not reflect the order in which they should be accomplished or take priority over any other recovery tasks, unless indicated. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

1) Control feral goats and other ungulates.

Habitat degradation by feral goats threatens both the Kauai and Maui populations (S. Perlman, personal communication 1995). In addition, the Maui populations are threatened by domestic cattle grazing (R. Hobdy, personal communication 1995).

2) Monitor extant populations and control alien weed threats, if possible.

The Kauai populations of this species are on cliffs and are inaccessible as far as weed control (S. Perlman, personal communication 1995).

3) Survey likely areas for additional populations and implement protective measures if necessary.

There is a lot of potential habitat for this plant on Kauai, although much of the habitat is inaccessible (S. Perlman, personal communication 1995). On Oahu, the Kaena Pt. population has not been seen in recent years (S. Perlman, personal communication 1995; J. Obata, personal communication 1995). The Kaena Pt. area needs to be resurveyed to determine if the population is still extant (J. Lau, personal communication 1995).

4) Propagate and establish outplanted populations within areas protected from ungulates in former or suitable habitat.

If the Kaena Pt. population no longer exists, this area may be suitable as an outplanting site.

5. *Chamaesyce celastroides* var. *kaenana* - RP# 9

a. Description and Taxonomy

Suitable drawings depicting *Chamaesyce celastroides* var. *kaenana* are not available.

Sherff (1936) described *Euphorbia celastroides* var. *kaenana* (now known as *Chamaesyce celastroides* var. *kaenana*) based upon a 1911 collection by Forbes, and named it after the geographical area in which Forbes had collected the specimen. He previously had described *E. celastroides* var. *niuensis* based upon a Hillebrand specimen collected in the Niu area of Oahu in the late

1800s (Sherff 1936). The Degeners (Degener and Degener 1959) and Leon Croizat accepted the elevation of the section *Chamaesyce* to the generic level and published the necessary combinations for the Hawaiian taxa (Croizat 1943; Degener and Croizat 1936a, 1936b, 1937). Further research (Herbst 1971, Pearcy and Troughton 1975, Perry 1943, Robichaux and Pearcy 1980) has supported retaining this separation. Daryl L. Koutnik (1987, Koutnik and Huft 1990), the most recent monographer of the genus in Hawaii, placed variety *niuensis*, which has not been collected since Hillebrand's time, in synonymy under variety *kaenana*.

Chamaesyce celastroides var. *kaenana*, a member of the spurge family (Euphorbiaceae), is a low-growing or upright shrub to 5 feet (1.5 meters) tall with milky sap. The leaves, which fall off during the dry season, are mostly hairless and are arranged in two opposite rows along the stem; they are 0.8 to 2.6 inches (20 to 65 millimeters) long and 0.3 to 0.8 inches (8 to 20 millimeters) wide, being widest at the tip. Flower clusters (cyathia) are crowded on small side branches and each produces a small, erect capsule. Seeds are small, spherical, and gray or white. This species is distinguished from other members of the genus in the area in which it grows in that it is a woody shrub; the other members of the genus in the area are herbs or small subshrubs (USFWS 1991b).

b. Life History

Chamaesyce celastroides var. *kaenana* has been observed flowering and fruiting throughout the year, probably in response to precipitation. Fruits mature in 3-4 weeks and plants live from 5-10 years (J. Obata, personal communication 1995).

c. Habitat Description

Chamaesyce celastroides var. *kaenana* typically grows in coastal dry shrubland on windward talus slopes at an elevation of 30 to 700 feet (9 to 640 meters) (USFWS 1991b). Associated taxa include *Gossypium tomentosum* (ma'o), *Jacquemontia ovalifolia* ssp. *sandwicensis* (pa'uohi'iaka), *Santalum freycinetianum* (sandalwood), and *Sida fallax* ('ilima) (USFWS 1991b).

d. Historic and Current Range and Population Status

Historically, *Chamaesyce celastroides* var. *kaenana* was known from the northwestern end of the Waianae Mountains as well as from one collection from the southeastern end of the Koolau Mountains (USFWS 1991b, Koutnik 1987, Koutnik and Huft 1990). This taxon remains only in the vicinity of Kaena Point on State and Federal land (HHP 1994a). The 11 known populations, which are all located within an area of about 1 by 3 miles (1.6 by 5 kilometers), contain approximately 545 individuals (HHP 1994a).

e. Reasons for Decline and Current Threats

The major threats to *Chamaesyce celastroides* var. *kaenana* are competition from the alien plant species, koa haole and kaiwe; fire; and effects of recreational activities (USFWS 1991b).

f. Conservation Measures

The DLNR restricted off-road vehicle access to the Kaena Point NAR by constructing a large barrier on the Mokuleia side of the reserve. Access from the Waianae side is prevented by a natural washout. Other management activities in the NAR include weeding of koa haole and kiawe in the vicinity of *Chamaesyce celastroides* var. *kaenana* and outplanting (Talbert Takahama, DLNR, personal communication 1995; J. Reyes, personal communication 1995).

g. Needed Recovery Actions

Below is a suggested species-specific recovery action. This action does not reflect the order in which it should be accomplished or take priority over any other recovery tasks. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

1) Establish cooperative management agreements between DLNR and the Department of Defense (Army) to protect the Kaena Pt. area from fire. This would include the development of a fire management plan.

6. *Chamaesyce kuwaleana* - RP# 8

a. Description and Taxonomy

Suitable drawings depicting *Chamaesyce kuwaleana* are not available.

Based on a collection by Degener from Mauna Kuwale, Sherff and Degener (Sherff 1949) described *Euphorbia kuwaleana* as a new species. Otto and Isa Degener (1959) subsequently transferred the species to the genus *Chamaesyce*.

Chamaesyce kuwaleana, a member of the spurge family, is an erect shrub 8 to 36 inches (20 to 90 centimeters) tall. The leaves, arranged in two rows along the stem, are 0.4 to 1 inches (11 to 25 millimeters) long and 0.3 to 0.6 inches (8 to 15 millimeters) wide; they are oval to occasionally circular in outline, and have a whitish waxy coating on the upper surface. Flower clusters (cyathia) are situated singly in the leaf axils, or sometimes at the branch tips. This species is distinguished from other species of the genus in its habitat by its stalked, oval to rounded leaves with untoothed margins, and the bent stalk supporting the small capsule (USFWS 1991b).

b. Life History

Chamaesyce kuwaleana bears fruits in spring and early summer and is usually done fruiting by the fall (J. Obata, personal communication 1995).

c. Habitat Description

Chamaesyce kuwaleana typically grows on arid, exposed volcanic cliffs at an elevation of 600 to 1,050 feet (180 to 320 meters) (USFWS 1991b). Associated species include 'ilima and *Dodonaea viscosa* ('a'ali'i) (USFWS 1991b).

d. Historic and Current Range and Population Status

Historically, *Chamaesyce kuwaleana* is known from the central Waianae Mountains and Moku Manu Island off the eastern coast of Oahu (USFWS 1991b, Koutnik and Huft 1990). This species is currently known from Kauaopuu Peak, Puu Kuwale, and Puu Kailio, on Federal and State land (HHP 1994a; S. Perlman, personal communication 1994). The three populations are 3 miles (4.8 kilometers) apart and contain approximately 2,000 individuals (HHP 1994a; S. Perlman, personal communication 1994).

e. Reasons for Decline and Current Threats

The major threats to *Chamaesyce kuwaleana* are competition from the alien plant species, koa haole and buffelgrass (*Cenchrus ciliaris*); fire; and the small number of populations (USFWS 1994b).

f. Conservation Measures

No specific conservation measures are being conducted for *Chamaesyce kuwaleana* except those mentioned in the Overall Conservation Efforts section of this plan.

g. Needed Recovery Actions

Below is a suggested species-specific recovery action. This action does not reflect the order in which it should be accomplished or take priority over any other recovery tasks. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

1) Develop fire management plans for Lualualei Military Reservation (Navy) and Waianae Kai Forest Reserve (DLNR) and control fires.

7. *Cyanea grimesiana* ssp. *obatae* - RP# 6

a. Description and Taxonomy

Appendix E contains a line drawing of *Cyanea grimesiana* spp. *obatae*.

Harold St. John (1978) described *Cyanea grimesiana* spp. *obatae* based upon a specimen collected by John K. Obata in Kaluaa Gulch of the Waianae Mountains, Oahu, in 1965. St. John named the subspecies in honor of its discoverer.

Cyanea grimesiana ssp. *obatae*, a member of the bellflower family (Campanulaceae), is a shrub, usually unbranched, growing from 3.3 to 10.5 feet (1 to 3.2 meters) tall. Its leaves are 10.5 to 23 inches (27 to 58 centimeters) long by 5.5 to 12.5 inches (14 to 32 centimeters) wide and are deeply cut into 9 to 12 lobes per side. The plant usually has small prickles on its stem and leaves. Clusters of 6 to 12 stalked flowers arise from the leaf axils. Sepals are fused to the ovary forming a cup 0.3 to 0.6 inches (0.7 to 1.6 centimeters) long with small, narrow, triangular lobes at the tips. The petals are purplish or greenish to yellow-white, often washed or striped with magenta, and are about 2 to 3 inches (5.5 to 8 centimeters) long and 0.2 to 0.4 inches (0.5 to 1 centimeters) wide. Fruits are elliptical orange berries, 0.7 to 1.2 inches (1.8 to 3 centimeters) long. This subspecies can be distinguished from the other two by its short, narrow, calyx lobes which are not fused or overlapping (USFWS 1994).

b. Life History

Cyanea grimesiana spp. *obatae* flowers and fruits year round, depending on rainfall (J. Obata, personal communication 1995).

c. Habitat Description

Cyanea grimesiana ssp. *obatae* typically grows on steep, moist, shaded slopes in diverse mesic to wet forests at an elevation of 1,800 to 2,200 feet (550 to 670 meters) (USFWS 1994). Associated plants include both native and introduced species such as *Pipturus albidus* (mamaki), *Charpentiera* (papala), *Claoxylon sandwicense* (po'ola), *Pisonia* (papala kepau), *Acacia koa* (koa), *Aleurites moluccana* (kukui), *Cyanea membranacea* (haha), and various fern taxa (USFWS 1994).

d. Historic and Current Range and Population Status

Historically, *Cyanea grimesiana* ssp. *obatae* is known from the southern Waianae Mountains from Puu Hapapa to Kaaikukai (USFWS 1994, Lammers 1990), a distance of about 4 miles (6.5 kilometers). This taxon is known to be extant in Kaluaa, Ekahanui, and North Palawai, on Federal and private land. The three populations are 4 miles apart (6.4 kilometers) and contain 17 individuals (HHP 1994a).

e. Reasons for Decline and Current Threats

The major threats to *Cyanea grimesiana* ssp. *obatae* are competition from alien plant taxa such as *Clidemia hirta* (Koster's curse) and *Schinus terebinthifolius* (Christmas berry); predation of seeds or fruits by introduced slugs and rats; damage to flowers and stems of plants by rats; damage by spotted leafhopper; and stochastic extinction and/or reduced reproductive vigor due to the small number of extant individuals (USFWS, 1994; J. Crummer, personal communication 1995). Habitat degradation by feral pigs is also a threat (USFWS 1994).

f. Conservation Measures

TNC is monitoring and controlling alien weeds for the population of 12 plants in Ekahanui Gulch. Field crews also counted and mapped plants, and gathered basic phenological data (J. Crummer, personal communication 1995).

g. Needed Recovery Actions

Below is a suggested species-specific recovery action. This action does not reflect the order in which it should be accomplished or take priority over any other recovery tasks. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

1) Control pigs.
Pigs are an immediate threat to the Kaluaa Gulch population. If it is determined that this population cannot be fenced, other pig control measures need to be implemented as soon as possible.

8. *Cyanea pinnatifida* - RP# 5

a. Description and Taxonomy

Appendix E contains a line drawing of *Cyanea pinnatifida*.

Cyanea pinnatifida was first collected in 1817 by Chamisso who later named it *Lobelia pinnatifida* (Chamisso 1833), the specific epithet referring to the lobed leaves. George Don (1834) transferred the species to the genus *Rollandia*, and two years later Karel Borowag Presl (1836) transferred it to the genus *Delissea*. In 1943, Franz Elfried Wimmer transferred this species to the genus *Cyanea*. The taxon Degener (1932c) described as *C. selachicauda* is considered conspecific with this species.

Cyanea pinnatifida, a member of the bellflower family (Campanulaceae), is a shrub, usually unbranched, growing from 2.6 to 10 feet (0.8 to 3 meters) tall. Leaves are 10 to 24 inches (25 to 60 centimeters) long by 6 to 20 inches (16 to 50 centimeters) wide and are deeply cut into 2 to 6 lobes per side. Clusters of 8 to 15 stalked flowers arise from the leaf axils. Sepals are fused to form a tube 0.4 to 0.5 inches (10 to 12 millimeters) long with small triangular lobes at the tips. The petals are greenish-white with purple stripes, and are about 2 inches (5 centimeters) long and 0.2 inches (4 to 5 millimeters) wide. Fruits have not been seen. This species differs from other members of the genus on Oahu by its leaves, which are deeply cut into two to six lobes per side. The only other member of the genus on Oahu with lobed leaves has 9 to 12 lobes per side (USFWS 1991b).

b. Life History

The single remaining wild plant has never produced seeds or flowers, probably because of limited sunlight and/or immaturity (S. Perlman, personal communication 1995).

c. Habitat Description

Cyanea pinnatifida typically grows on steep, wet, rocky slopes in diverse mesic forest at an elevation of 1,600 to 1,700 feet (490 to 520 meters) (USFWS 1991b). Associated plants include mamaki and ferns (USFWS 1991b).

d. Historic and Current Range and Population Status

Historically, *Cyanea pinnatifida* is known from the central Waianae Mountains (USFWS 1991b, Lammers 1990). Only one individual of this species remains, in Kaluaa Gulch on privately owned land (HHP 1994a).

e. Reasons for Decline and Current Threats

The major threats to *Cyanea pinnatifida* are the small number of extant individuals; competition from the alien plant species, (Koster's curse); habitat degradation by feral pigs; and collection or trampling by humans on or near trails (USFWS 1991b).

f. Conservation Measures

No specific conservation measures are being conducted for *Cyanea pinnatifida* except those mentioned in the Overall Conservation Efforts section of this plan.

g. Needed Recovery Actions

Below are some suggested species-specific recovery actions. These actions do not reflect the order in which they should be accomplished or take priority over any other recovery tasks, unless indicated. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

1) Little can be done to protect the single remaining wild plant because of its precarious location.

The greatest threat is a stochastic environmental disturbance such as washout, falling rocks and trees. *Cyanea pinnatifida* is not immediately threatened by alien weeds, and weeding of Koster's curse on the steep slope above the plant could threaten the plant more than the weeds themselves. The plant is not directly threatened by pigs because of its location on the side of a gulch wall, and fencing is not feasible.

2) Monitor remaining wild plant for changes in status and threats and implement management actions to protect remaining wild plant, if possible.

Potential management actions include weeding and control of feral pigs, slugs, and rats if they are determined to be threats.

3) Monitor remaining wild plant for changes in reproductive status.

Collect seeds for ex-situ propagation if fruits are produced.

9. *Cyanea superba* - RP# 5

a. Description and Taxonomy

Appendix E contains a line drawing of *Cyanea superba*.

Cyanea superba was first collected on Oahu in 1817 by Adelbert Chamisso, botanist with the Romanzoff Expedition, and was placed by him in the genus *Lobelia* (Chamisso 1833). No information on the collecting locality was given other than the island. Asa Gray (1861) later transferred the species to the endemic genus *Cyanea*. Dr. Hillebrand collected the species in the "Gulches of Makaleha on Mt. Kaala," Waianae Mountains, Oahu. He collected it again in 1870, and there were no further documented sightings of the taxon until its rediscovery in the Waianae Mountains in 1971 (USFWS 1991a). Two varieties are recognized: var. *regina*, which is thought to be extinct, and var. *superba* which was rediscovered (M. Bruegmann, personal communication 1995).

Cyanea superba is a perennial plant in the bellflower family (Campanulaceae) and is geographically isolated and morphologically very different from its closest relatives. It grows to 20 feet (6 meters) tall, and has a terminal rosette of large leaves each 20 to 40 inches (50 to 100 centimeters) long and 4 to 8 in (10 to 20 centimeters) wide atop a simple, unbranched trunk. Its numerous white or creamish flowers are in pendent inflorescences hanging 8 to 14 inches (20 to 35 centimeters) below the leaves (USFWS 1991a).

b. Life History

The flowering season of *Cyanea superba* varies from year to year depending on precipitation. It ranges from late August to early October. Generally, flowering is at its peak in early to mid-September. Fruits generally mature in about two months, depending on the climatic conditions. After the corolla emerges from the calyx "capsule," it takes about four weeks for the corolla to open (Obata and Smith 1981).

c. Habitat Description

Cyanea superba grows in the understory on sloping terrain on a well drained, rocky substrate between 1,760 and 2,200 feet (535 and 700 meters) in elevation. The understory is heavily shaded by canopy species including *Aleurites moluccana* (kukui) and *Pisonia brunoniana* (papala kepau), but is open. The open, shaded understory provides an environment conducive to invasion by aggressive exotic species (USFWS 1991a). One population is on State land in Pahole Gulch, while the other grows on Federal property in Kahanahaiki Valley, Waianae Mountains, Oahu, Hawaii.

d. Historic and Current Range and Population Status

Historically, *Cyanea superba* is known from the "Gulches of Makaleha on Mt. Kaala," Waianae Mountains, Oahu. After its collection in 1870, there were no further documented sightings of the taxon until its rediscovery in the Waianae Mountains in 1971. Presently it is known from 2 small populations on Federal and State land, totaling less than 10 plants (R. Kennedy, personal communication 1995). A recently reported third population appears to be based on a misidentification (USFWS 1991a).

e. Reasons for Decline and Current Threats

Probably the greatest immediate threat to the survival of *Cyanea superba* is the degradation of its habitat due to the introduction of alien plants and animals. The potential of destruction by wildfires generated in a nearby military firing range and damage directly to the plants and their habitat by feral pigs also are major threats. The plants are confined to 2 small areas of 167 and 56 square (sq.) meters (1,800 and 600 sq. feet). The restricted range of this plant makes it vulnerable to even small, local, environmental disturbances and a single incident could destroy a significant percentage of the known individuals. Additionally, the limited gene pool may depress reproductive vigor (USFWS 1991a).

f. Conservation Measures

The Army has developed a fire management plan for Makua Military Reservation and has also established a firebreak which enhances the protection of this species.

The DLNR has fenced both wild populations of *Cyanea superba* to protect individuals from pig damage, and crews monitor and maintain the fences. DLNR is not presently weeding the fenced populations because alien weeds do not appear to be a direct threat and weeding might disturb remaining wild plants (T. Takahama, personal communication 1995).

DLNR has also propagated and outplanted 40 individuals in Pahole Gulch NAR and is monitoring their survival. Thirty-three more individuals are available for outplanting at the mid-elevation nursery at the Nike Site (B. Garnett, personal communication 1995; J. Reyes, personal communication 1995).

g. Needed Recovery Actions

Below is a suggested species-specific recovery action. This action does not reflect the order in which it should be accomplished or take priority over any other recovery tasks. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

1) Relocate and protect *Cyanea superba* var. *regina*, if this variety still exists, in order to conserve genetic material (Loyal Mehroff, USFWS, personal communication 1995).

10. *Diellia falcata* - RP# 8

a. Description and Taxonomy

Appendix E contains a line drawing of *Diellia falcata*.

William Dunlop Brackenridge discovered three new species of *Diellia*, including *Diellia falcata*, in 1840 during the Wilkes Expedition. When describing the species in 1845, he noted that the genus *Diellia* was similar to the genus *Schizoloma*, differing only in its interrupted sori (groups of spore-producing bodies) (Degener and Greenwell 1950). In 1857, Thomas Moore included *Diellia* in the genus *Schizoloma* (Wagner 1952) and in 1861 transferred *D. falcata* to *Schizoloma* (Moore 1861). William Jackson Hooker and John Gilbert Baker (1883) transferred the species to *Lindsaea*, giving rise to the name *Lindsaya* [sic]

(*Diellia*) *falcata*. Degener and Amy B. H. Greenwell (1950) treated the simple pinnate members of the species as varieties of *Diellia erecta*, resulting in the name *Diellia erecta* var. *falcata*. The most recent interpretations (Lamoureux 1988; Wagner 1952, 1987) again accept the taxon at the specific level.

Diellia falcata, in the fern family Polypodiaceae, grows from a rhizome (underground stem) 0.4 to 2 inches (1 to 5 centimeters) long and 0.2 to 0.8 inches (0.5 to 2 centimeters) in diameter, which is covered with small black or maroon scales. Stalks of the fronds are dark brown to pale tan, usually have a dull surface, and are 0.4 to 2 [illegible] inches (1 to 7 centimeters) long. The fronds are long and oval or straight in outline and 8 to 40 inches (20 to 100 centimeters) tall by 1.0 to 3.5 inches (2.5 to 9 centimeters) wide, with 12 to 45 divisions (pinnae) per side. The lower pinnae are small and rounded while pinnae farther up the frond are larger, undivided, and shaped like a sickle or a long triangle with veins forming a netted textured surface pattern. The sori are shaped like short lines 0.04 to 0.1 inches (1 to 3 millimeters) long and are on low projections of the pinna margin. This species is distinguished from others in the genus by the color and texture of its leaf stalk, the venation pattern of its fronds, the color of its scales, its rounded and reduced lower pinnae, and its separate sori arranged on marginal projections (USFWS 1991b).

b. Life History

Diellia falcata hybridizes with *Diellia unisora* (J. Lau, personal communication 1995). Otherwise, little is known about its life history.

c. Habitat Description

Diellia falcata is a terrestrial fern which typically grows in deep shade or open understory in dryland forest at an elevation of 1,280 to 2,700 feet (390 to 820 meters) (USFWS 1991b). Associated species include aulu, *Diospyros sandwicensis* (lama), and *Pouteria sandwicensis* ('ala'a) (USFWS 1991b).

d. Historic and Current Range and Population Status

Historically, *Diellia falcata* was known from almost the entire length of the Waianae Mountains, from Manini Gulch to Palehua Iki, as well as from the Koolau Mountains of Oahu, from Kaipapau Valley to Aiea Gulch (USFWS 1991b). This species remains in the Waianae Mountains, from Manini Gulch to Puu Hapapa, Makua Valley and Makaha-Waianai Kai Ridge on Federal, State, and private land (HHP 1994a, 1994b, 1994c). The 21 known populations, which are found within an area of about 2 by 11 miles (3.2 by 18 kilometers), contain an estimated 5,540-6,540 individuals (HHP 1994a, 1994b, 1994c).

e. Reasons for Decline and Current Threats

The major threats to *Diellia falcata* are habitat degradation by feral goats, pigs, and cattle; competition from alien plant species (Christmasberry, huehue haole, Koster's curse, molasses grass, *Psidium cattleianum* (strawberry guava), and *Blechnum occidentale*); and fire (USFWS 1991b).

f. Conservation Measures

TNC is monitoring one population in Waieli Gulch (J. Crummer, personal communication 1995).

g. Needed Recovery Actions

Below are some suggested species-specific recovery actions. These actions do not reflect the order in which they should be accomplished or take priority over any other recovery tasks, unless indicated. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

1) Conduct research into additional limiting factors. The leafhopper is a potential threat to *Diellia falcata*, and should be investigated (J. Lau, personal communication 1995).

2) Investigate taxonomic relationship and genetic distinctiveness of *Diellia falcata* and *Diellia unisora* and determine which populations are hybridizing (J. Lau, personal communication 1995).

11. *Diellia unisora* - RP# 11

a. Description and Taxonomy

Suitable drawings depicting *Diellia unisora* are not available.

Donald L. Topping discovered *Diellia unisora* growing on a shaded, mossy bank in Pohakea Pass, Waianae Mountains, Oahu, in 1932. It was first reported and illustrated by Frances Smith who believed it to be a specimen of *Diellia pumila*, although she pointed out several differences between that species and the Topping specimen. Warren H. Wagner, Jr., believing that the plant discovered by Topping merited specific recognition, described the new species, giving it the specific epithet *unisora* in reference to the usually single, marginal spore-producing body (USFWS 1994).

Diellia unisora, in the fern family Polypodiaceae, grows from a slender, erect rhizome (underground stem), 0.2 to 1.2 inches (0.5 to 3 centimeters) tall and 0.2 to 0.4 inches (0.5 to 1 centimeter) in diameter, which is covered with the bases of the leaf stalks and a few small black scales. Stalks of the fronds are black and shiny, and about 0.8 to 2 inches (2 to 5 centimeters) long. The fronds are linear, 3 to 12 inches (8 to 30 centimeters) tall by 0.2 to 1.2 inches (0.5 to 3 centimeters) broad, with 20 to 35 pinnae (leaflets) per side, and gradually narrowing towards the apex. The pinnae are usually strongly asymmetrical in outline, unequally triangular, with mostly entire (smooth) margins. There usually is a single marginal sorus (the spore-producing body) running along the upper margin of the underside of the pinna. This species is distinguished from others in the genus by a rhizome completely covered by the persisting bases of the leaf stalks, and few, very small scales; by sori mostly confined to the upper pinnae margins; and by delicate fronds gradually and symmetrically narrowing toward the apex (USFWS 1994).

b. Life History

Diellia unisora hybridizes with *Diellia falcata* (J. Lau, personal communication 1995). Otherwise, little is known about its life history.

c. Habitat Description

Diellia unisora is a terrestrial fern which typically grows in deep shade or open understory in dryland forest at an elevation of 1,750 to 2,500 feet (530 to 760 meters) (USFWS 1994). Associated species include koa, Christmas berry, *Psidium cattleianum* (strawberry guava), and *Metrosideros polymorpha* ('ohi'a), and a mixture of alien and native grasses, forbs, and shrubs (USFWS 1994).

d. Historic and Current Range and Population Status

Historically, *Diellia unisora* was known from steep, grassy, rocky slopes on the western side of the Waianae Mountains, Oahu (USFWS 1994; Wagner 1952). This species is known to be extant in four areas of the southern Waianae Mountains: South Ekahanui Gulch, Palawai Gulch, Palikea, and the Pualii-Napepeiauolelo Ridge (HHP 1994a, 1994b; J. Lau, personal communication 1994). The four known populations, which are on State and privately owned land, are scattered over a distance of about 2 miles (3.2 kilometers), and contain approximately 700 individuals (HHP 1994a, 1994b; J. Lau, personal communication 1995).

e. Reasons for Decline and Current Threats

The major threat to *Diellia unisora* is competition from alien plant taxa (Christmas berry, *Melinus minutiflora* (molasses grass), *Passiflora suberosa* (huehue haole), strawberry guava, and *Blechnum occidentale*). Habitat degradation by feral pigs is also a threat (USFWS 1994).

f. Conservation Measures

No specific conservation measures are being conducted for *Diellia unisora* except those mentioned in the Overall Conservation Efforts section of this plan.

g. Needed Recovery Actions

Below are some suggested species-specific recovery actions. These actions do not reflect the order in which they should be accomplished or take priority over any other recovery tasks, unless indicated. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

1) Conduct research into additional limiting factors.
The leafhopper is a potential threat to *Diellia unisora*, and should be investigated (J. Lau, personal communication 1995).

2) Investigate taxonomic relationship and genetic distinctiveness of *Diellia falcata* and *Diellia unisora* and determine which populations are hybridizing (J. Lau, personal communication 1995).

12. *Dubautia herbstobatae* - RP# 8

a. Description and Taxonomy

Suitable drawings depicting *Dubautia herbstobatae* are not available.

Derral R. Herbst and John K. Obata in 1971 made the first collection of *Dubautia herbstobatae*, which was later described and named to honor its discoverers (Carr 1979). In 1830, Charles Gaudichaud-Beaupre described two closely related Hawaiian genera in the aster family; *Railliardia* has united bracts under the flower head and *Dubautia* has bracts which are distinct. Today, most botanists consider *Railliardia* and *Dubautia* as sections of the genus *Dubautia* (Carr 1990). However, Harold St. John, believing that the separation should be maintained, transferred *D. herbstobatae* to the genus *Railliardia* (St. John 1981a), a course few botanists follow. The current taxonomic treatment (Carr 1990) recognizes only the genus *Dubautia*.

Dubautia herbstobatae, a member of the aster family (Asteraceae), is a small, spreading shrub to 20 inches (50 centimeters) tall. The shiny, leathery leaves are oppositely arranged, narrowly elliptic in outline, and 0.8 to 2.2 inches (2 to 5.5 centimeters) long by 0.1 to 0.4 inches (3 to 11 millimeters) wide. They usually have one main vein and smooth or nearly smooth margins. There are 5 to 15 heads in an inflorescence, each composed of 4 to 20 yellowish-orange, tubular florets, 0.1 to 0.2 inches (3 to 5 millimeters) long. The fruit is comprised of a seed with a dry, unopening fruit wall (an achene) covered with silky gray hair. Only 2 species of the genus on Oahu have the outer bracts of the flower heads fused, forming a cup surrounding the florets; of those 2 species, *D. herbstobatae* has 1 large vein showing in each leaf, while the other species has 5 to 11 veins (USFWS 1991b).

b. Life History

Dubautia herbstobatae is likely out-crossing and possibly self-incompatible. Flowering usually occurs in May and June. Pollination is almost certainly achieved by insect activity and fruit dispersal is probably quite localized (Carr 1982).

c. Habitat Description

Dubautia herbstobatae typically grows on rock outcrops on north-facing ridges in dry shrubland at an elevation of 1,900 to 3,000 feet (580 to 910 meters) (USFWS 1991b). Associated species include 'ohi'a and *Eragrostis variabilis* (kawelu) (USFWS 1991b).

d. Historic and Current Range and Population Status

Dubautia herbstobatae is known to be extant in the northern Waianae Mountains, on Makua-Keaau, Waianae Kai and Kamaileunu ridges, and Keaau Valley on Federal, State, and City/County land (HHP 1994a, 1994b). No other locations are known for this recently discovered species (Carr 1979, 1982). The 4 known populations, which are scattered over an area of about 1 by 3 miles (1.6 by 4.8 kilometers), contain approximately 3,000-4,000 individuals (HHP 1994a, 1994b; S. Perlman, personal communication 1994).

e. Reasons for Decline and Current Threats

The major threats to *Dubautia herbstobatae* are habitat degradation by feral goats and pigs, competition from alien plant species (daisy fleabane, Christmasberry, koa haole, and molasses grass), fire, and visitation and possible trampling by humans (USFWS 1991b).

f. Conservation Measures

No specific conservation measures are being conducted for *Dubautia herbstobatae* except those mentioned in the Overall Conservation Efforts section of this plan.

g. Needed Recovery Actions

There are no known species-specific recovery actions for this species at this time. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

13. *Gouania meyenii* - RP# 5

a. Description and Taxonomy

Appendix E contains a line drawing of *Gouania meyenii*.

Gouania meyenii was collected by Franz Julius Ferdinand Meyen in 1831 and named *Gouania integrifolia* by him (Meyen 1834), a name previously used by Jean Baptiste Lamarck in 1789 for another plant (St. John 1969). Ernesto Theoph Steudel (1840) renamed the plant *Gouania meyenii*, the species epithet honoring Meyen. Gerhard Walpers (1843), realizing that Meyen had erred in the use of the specific epithet *integrifolia*, but unaware of Steudel's publication, named the taxon *Gossania orbicularis*, the spelling of the genus name being a printer's error. St. John later described two additional species, *Gouania oliveri* (St. John 1969) and *Gouania gagnei* (St. John 1973), which are currently considered synonyms of *Gouania meyenii* (Wagner *et al*. 1990).

Gouania meyenii, a member of the buckthorn family (Rhamnaceae), is a shrub up to 7 feet (2.2 meters) tall. Leaves are papery in texture, smooth on the upper surface, and with no teeth on the margins. The leaves are oval or broader in outline and 1.2 to 2.8 inches (3 to 7 centimeters) long by 0.6 to 1.8 inches (1.6 to 4.5 centimeters) wide. Flowers are possibly functionally unisexual, with male flowers and female flowers on the same plant. They are arranged in clusters originating in the leaf axils. Sepals are 0.06 to 0.1 inches (1.5 to 3 millimeters) long and white; petals are 0.05 to 0.07 in (1.2 to 1.8 mm) long and also white. The 2- or 3-winged fruits are 0.4 to 0.6 inches (9 to 16 millimeters) long. Seeds are brown and 0.2 to 0.3 inches

(5 to 7 millimeters) long. This species is distinguished from the two other Hawaiian species of *Gouania* by its lack of tendrils on the flowering branches, the absence of teeth on the leaves, and the lack or small amount of hair on the fruit (USFWS 1991b, Wagner *et al*. 1990).

b. Life History

Gouania meyenii flowers from March to May. Seed capsules develop in about 6-8 weeks. Plants appears to live about 10-18 years in the wild (J. Obata, personal communication 1995).

c. Habitat Description

Gouania meyenii typically grows on rocky ledges, cliff faces, and ridge tops in dry shrubland or 'ohi'a lowland mesic forest at an elevation of 1,900 to 2,700 feet (580 to 820 meters) (USFWS 1991b). Associated species include 'a'ali'i, lama, *Lysimachia hillebrandii* (kolokolo kuahiwi), and *Senna gaudichaudii* (kolomona) (USFWS 1991b).

d. Historic and Current Range and Population Status

Historically, *Gouania meyenii* is known from central and southern areas of the Waianae Mountains, from Kamaileunu Ridge to Honouliuli (USFWS 1991b, Wagner *et al*. 1990). On Oahu, this species is now found on Kamaileunu Ridge and Makaha-Waianae Kai Ridge on State and City/County land (HHP 1994a; J. Lau, personal communication 1995). This species was recently discovered in two locations in the Na Pali-Kona Forest Reserve and one location in Koaie Canyon, all on Kauai (HHP 1994a). The 4 known populations on Oahu, which are in an area of about 1 square mile (2.6 square kilometers), contain an estimated 83 individuals (HHP 1994a). On Kauai, the three populations, located in Hipalau and Kalalau Valleys, contain an estimated 36 individuals and are within approximately 4 miles (9.6 kilometers) of each other (Ken Wood and S. Perlman, NTBG, personal communication 1994).

e. Reasons for Decline and Current Threats

The major threats to *Gouania meyenii* are competition from alien plant species (Christmasberry, molasses grass, and strawberry guava), fire, habitat degradation by feral pigs and goats, and the small number of extant populations (USFWS 1991b).

f. Conservation Measures

No specific conservation measures are being conducted for *Gouania meyenii* except those mentioned in the Overall Conservation Efforts section of this plan.

g. Needed Recovery Actions

There are no known species-specific recovery actions for this species at this time. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

14. *Gouania vitifolia* - RP# 5

a. Description and Taxonomy

Appendix E contains a line drawing of *Gouania vitifolia*.

Gouania vitifolia was first collected "on dry hills, in the district of Waianai [Waianae]" during the U.S. Exploring Expedition in 1840. Asa Gray was given the task of preparing a report on all of the foreign plants collected by the expedition. Of the two volumes he produced concerning these specimens, only one was published, and in it *Gouania vitifolia* was described as a new species in 1854. The species epithet was derived from the Latin *vitis*, a vine or grapevine, and *folium*, leaf, as the toothed leaves of this species resemble those of the grape. The Maui Island population of this species, first collected above Lahaina on West Maui by Edward F. Bishop, probably in the 1870s, was described and named *G. bishopii* in honor of its discoverer by William Hillebrand. In his monograph of the genus, St. John described *G. hawaiiensis* as a new species based upon a collection made in the Kau District of Hawaii Island in 1853 by Jules Remy. Both of these taxa are currently considered synonyms of *Gouania vitifolia* (USFWS 1994).

Gouania vitifolia, a member of the buckthorn family (Rhamnaceae), is a climbing shrub or woody vine with tendrils. Leaves are papery in texture with a moderate to dense covering of short, soft hairs on both surfaces. The leaves are elliptic to broadly oval in outline with toothed or lobed margins and 1.2 to 3.2 inches (3 to 8 centimeters) long by 0.8 to 1.9 inches (2 to 4.8 centimeters) wide. Flowers are arranged in axillary spikes 0.3 to 2.8 inches (0.8 to 7 centimeters) long. The flowers are small with sepals and petals ranging from 0.03 to 0.04 inches (0.7 to 1.1 millimeters) in length. Both the sepals and petals are white. The 2- or 3-winged fruit are about 0.4 inches (9 to 10 millimeters) long. Seeds are oval, glossy, dark brown, and about 0.1 to 0.2 inches (3.4 to 5 millimeters) long. This species is the only Hawaiian member of the genus with tendrils and toothed leaf margins (USFWS 1994).

b. Life History

In winter and spring the main vine of *Gouania vitifolia* produces new young side shoots which soon die. Plants have been observed flowering from late November to January, but flowering probably depends on precipitation (J. Obata, personal communication 1995).

Although plants have been observed flowering, *Gouania vitifolia* has never been observed fruiting and it is unknown whether the flowers are perfect. The remaining extant population consists of two patches of plants. One patch has a single plant and the second patch has four plants that probably all came from a single seed (J. Lau, personal communication 1995).

c. Habitat Description

Information is scant, but data from herbarium labels indicate that *Gouania vitifolia* prefers dry, rocky ridges and slopes in dry shrubland or dry to mesic forests at an elevation of about 2,000 feet (610 meters). Associated taxa include strawberry guava, kukui, Christmas berry, huehue haole, and mamaki (USFWS 1994).

d. Historic and Current Range and Population Status

Historically, *Gouania vitifolia* was known from West Maui; the Kau District of the island of Hawaii; and the northwestern portion of the Waianae Mountains in Makaleha, Keaau, and Waianae

Kai Valleys (USFWS 1994, St John 1969, Wagner *et al.* 1990). However, it is currently known from only a single population of five individuals, which was discovered in 1990 on the slopes of Waianae Kai Ridge on State-owned land on Oahu (HHP 1994a). The five plants are close to one another, growing in a single patch in a forest of mostly naturalized, non-native taxa (HHP 1994a), and may represent clones of a single individual (USFWS 1994). A second, smaller patch was discovered near the first, which probably represents a second clone.

e. Reasons for Decline and Current Threats

The major threats to *Gouania vitifolia* are competition from alien plant taxa such as *Passiflora edulis* (lilikoi), strawberry guava, and Christmas berry; habitat destruction by feral pigs; and stochastic extinction and/or reduced reproductive vigor due to the small number of extant individuals, all of which may be genetically identical (USFWS 1994).

f. Conservation Measures

No specific conservation measures are being conducted for *Gouania vitifolia* except those mentioned in the Overall Conservation Efforts section of this plan.

g. Needed Recovery Actions

Below is a suggested species-specific recovery action. This action does not reflect the order in which it should be accomplished or take priority over any other recovery tasks. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

1) Monitor remaining wild plants for changes in status and threats and implement management actions to protect, if necessary.

Potential management actions include weeding, control of feral pigs, and possibly leafhopper. It may be possible to carefully weed competing alien vines such as *Passiflora edulis* (lilikoi) from around remaining plants, but alien trees that support *Gouania vitifolia* should be left in place (J. Lau, personal communication 1995).

15. *Hedyotis degeneri* - RP# 5

a. Description and Taxonomy

Suitable drawings depicting *Hedyotis degeneri* are not available.

Francis Raymond Fosberg (1943) published *Hedyotis degeneri* based on a specimen collected by Otto Degener, and named it in his honor. Two varieties were recognized, the typical var. *degeneri* and one with narrower leaves (resembling leaves of *Coprosma*), var. *coprosmifolia* (Fosberg 1943). Hillebrand (1888) had included var. *coprosmifolia* as a questionable variety of *Kadua foliosa* when he published that name, noting that it might be a distinct species. Today both varieties are recognized (Wagner *et al*. 1990).

Hedyotis degeneri, a member of the coffee family (Rubiaceae), is a prostrate shrub with 4-sided stems and peeling, corky bark. Leaves are quite variable and range from long and thin to heart-shaped, from 0.4 to 1.2 inches (1 to 3 centimeters) in length and 0.1 to 0.8 inches (0.3 to 2 centimeters) in width. Flowers are arranged in groups of 1 to 10 inch (2.5 to 25.4 centimeter) clusters at the ends of the stems. Sepals are fused into a tube and flare into 4 or 5 leaflike lobes up to 0.3 inches (8 millimeters) long. Petals are fused into a trumpet-shaped tube 0.2 to 0.3 inches (6 to 7 millimeters) long with 4 or 5 lobes up to 0.2 inches (4 millimeters) long. Capsules are nearly globe-shaped and about 0.2 inches (4 to 5 millimeters) in diameter. Seeds are angled and almost black. This species can be distinguished from others in the genus on Oahu by its low-growing habit, the peeling corky layers on older stems, and the short, crowded, leafy shoots growing in the leaf axils (USFWS 1991b, Wagner *et al*. 1990).

b. Life History

Little is known about the life history of *Hedyotis degeneri*. Flowering cycle, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown.

c. Habitat Description

Hedyotis degeneri typically grows in diverse mesic forest at an elevation of 2,700 feet (820 meters) (USFWS 1991b). Associated species include 'ohi'a and *Hedyotis terminalis* (manono) (USFWS 1991b).

d. Historic and Current Range and Population Status

Historically, *Hedyotis degeneri* is known from Mt. Kaala in the northern Waianae Mountains (Wagner *et al.* 1990). This species is known from three populations consisting of six individuals located on Kamaileunu Ridge (HHP 1994a), 25 individuals located near Pahole Gulch (S. Perlman, personal communication 1994), and 1 individual located in Makaleha Valley (J. Lau, personal communication 1995). All of these populations occur on State-owned land.

e. Reasons for Decline and Current Threats

The major threats to *Hedyotis degeneri* are habitat destruction by feral pigs, competition from alien plant species (Christmasberry, molasses grass, and strawberry guava), and the small number of extant individuals (USFWS 1991b).

f. Conservation Measures

No specific conservation measures are being conducted for *Hedyotis degeneri* except those mentioned in the Overall Conservation Efforts section of this plan.

g. Needed Recovery Actions

Below is a suggested species-specific recovery action. This action does not reflect the order in which it should be accomplished or take priority over any other recovery tasks. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

1) Relocate and protect *Hedyotis degeneri* var. *coprosmifolia* in order to conserve genetic material. Conduct research on

taxonomic status and genetic distinctiveness of the two varieties (J. Lau, personal communication 1995).

16. *Hedyotis parvula* - RP# 5

a. Description and Taxonomy

Suitable drawings depicting *Hedyotis parvula* are not available.

The first specimen of *Hedyotis parvula* was collected by Heinrich Wawra; Gray (1859) later named the plant *Kadua parvula*, the specific epithet referring to its small size. In 1943, Fosberg transferred the species to the genus *Hedyotis*. He also named a form, f. *sessilis*, which is no longer recognized (Wagner *et al.* 1990).

Hedyotis parvula, a member of the coffee family, is a small, many-branched shrub, either upright or sprawling, with stems usually no more than 1 foot (30 centimeters) in length. Leaves are leathery in texture, overlapping, 0.4 to 1.6 inches (1 to 4 centimeters) long by 0.3 to 0.9 inches (7 to 23 millimeters) wide, and are uniform in size along the stem. Flowers are grouped in small clusters, and when combined with clusters on adjacent stems, give the appearance of a large inflorescence. Sepals are fused into a tube and flare into 4 or 5 lobes 0.04 to 0.16 inches (1 to 4 millimeters) long by 0.04 to 0.08 inches (1 to 2 millimeters) wide, often with different sizes on the same plant. The lobes enlarge up to 0.2 inches (5.5 millimeters) long as the fruit matures. The white petals are fused into a funnel-shaped tube 0.3 to 0.4 inches (8 to 11 millimeters) long with 4 or 5 purplish pink-tipped lobes, each about 0.2 inches (5 to 6 millimeters) long. The capsule is almost globe-shaped and about 0.2 inches (4 millimeters) in diameter. Seeds are angled and brown. Closely spaced, overlapping leaves which are uniform in size along the stem separate this species from other members of the genus on Oahu (USFWS 1991b).

b. Life History

Hedyotis parvula has been observed flowering in both winter and summer. The plant is found in dry areas and flowering may be induced by rain (J. Obata, personal communication 1995).

c. Habitat Description

Hedyotis parvula typically grows on and at the base of cliff faces, rock outcrops, and ledges in dry habitat at an elevation of 2,350 to 2,730 feet (720 to 830 meters) (USFWS 1991b). Associated species include 'a'ali'i, *Canthium odoratum* (alahe'e), and *Plectranthus parviflorus* ('ala'ala wai nui) (USFWS 1991b, Wagner *et al.* 1990).

d. Historic and Current Range and Population Status

Historically, *Hedyotis parvula* was known from the central and southern Waianae Mountains, from Makaleha Valley to Nanakuli Valley (Wagner *et al.* 1990). This species grew on Makaleha Ridge in 1986 and on Makua-Keaau Ridge in 1976, on State and Federally-owned land (USFWS 1991b; J. Lau, personal communication 1995). It is now known from four populations, all on Federally-owned land. Two of these populations occur on Makua Military Reservation (150 individuals), one population on Palikea Ridge between Nanakuli and Lualualei (60-75 individuals), and one population west of Palawai Gulch (10 individuals) (HHP 1994a, 1994b; S. Perlman, personal communication 1994; J. Lau, personal communication 1995).

e. Reasons for Decline and Current Threats

The major threats to *Hedyotis parvula* are habitat degradation by feral goats and pigs, competition from alien plant species (Christmasberry, daisy fleabane, pamakani, and molasses grass), and the small population size (USFWS 1991b).

f. Conservation Measures

No specific conservation measures are being conducted for *Hedyotis parvula* except those mentioned in the Overall Conservation Efforts section of this plan.

g. Needed Recovery Actions

Below is a suggested species-specific recovery action. This action does not reflect the order in which it should be accomplished or take priority over any other recovery tasks.

Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

1) Control feral goats and pigs.
If general control measures are not undertaken for these ungulates, strategic fencing of the Palikea ridge population should be considered because it would prevent pigs from degrading the area and reaching accessible parts of the population as well as prevent goats from moving up the ridge.

17. *Hesperomannia arbuscula* - RP# 5

a. Description and Taxonomy

Appendix E contains a line drawing of *Hesperomannia arbuscula*.

Hillebrand (1888) described *Hesperomannia arbuscula* based on a specimen collected by E. Bishop on Maui, the specific epithet referring to the smaller stature of the plant as compared to the previously described species of the genus, *H. arborescens*. At the same time, Hillebrand also described *H. arborescens* var. *oahuensis*, a taller tree from Oahu, which was later raised to specific status (*H. oahuensis*) by Degener (1938). Sherwin Carlquist (1957) examined fresh material of both the Maui and Oahu plants and decided a new combination, *H. arbuscula* ssp. *oahuensis*, was in order for Oahu plants, as compared to those on Maui, which he called ssp. *arbuscula*. However, examination of additional specimens showed that there were no valid differences between the taxa (Wagner *et al.* 1990). St. John later published *H. arbuscula* var. *pearsallii* (1978) and *H. mauiensis* (1983), neither of which is now recognized as a valid taxon (Wagner *et al.* 1990).

Hesperomannia arbuscula, a member of the aster family, is a small shrubby tree, 7 to 11 feet (2 to 3.3 meters) tall. Leaves are elliptic, generally 4 to 7 inches (10 to 18 centimeters) long and 2.2 to 4.5 inches (5.5 to 11.5 centimeters) wide, although leaves on juvenile plants can sometimes be larger. Flower heads are erect and arranged in clusters of four or five heads. Each head comprises many yellow to yellowish-brown florets, with a tube of fused petals 0.9 to 1.2 inches (2.5 to 3 centimeters) long and a threadlike style extending beyond them. The fruit is a 0.3 to 0.4 inches (0.8 to 1 centimeters) long achene, crowned by a ring of bristles nearly the same length as the petals. This species can be distinguished from other members of the genus by the erect flower heads and the leaves, usually hairy beneath, which are one to two times as long as wide (USFWS 1991b, Wagner *et al*. 1990).

b. Life History

Hesperomannia arbuscula usually flowers in the spring depending on precipitation. Seeds mature in about six weeks and trees last about 10-15 years (J. Obata, personal communication 1995).

c. Habitat Description

Hesperomannia arbuscula typically grows on slopes and ridges in mesic to wet forest dominated by koa and 'ohi'a at an elevation of 1,200 to 3,000 feet (350 to 900 meters) (USFWS 1991b, Wagner *et al*. 1990). Associated species include ko'oko'olau, *Alyxia oliviformis* (maile), and *Psychotria* (kopiko) (USFWS 1991b).

d. Historic and Current Range and Population Status

Historically, *Hesperomannia arbuscula* is known from the central and southern Waianae Mountains, from Makaleha to Puu Kanehoa, and from West Maui (USFWS 1991b). This species is currently known to be extant on the Makaha-Waianae Kai Ridge, Kaluaa Gulch, and Kapuna Gulch on Oahu and in Iao Valley on West Maui, on State and private land (HHP 1994a, 1994b; J. Lau, personal communication 1994). The five known populations on Oahu are located within an area of about 2 by 5 miles (4.8 by 8 kilometers). Including the sixth population from West Maui, this species numbers about 86 individuals (HHP 1994a, 1994c; J. Lau, personal communication 1994).

e. Reasons for Decline and Current Threats

The major threats to *Hesperomannia arbuscula* are habitat degradation by feral pigs, competition from alien plant species (blackberry, Christmasberry, Koster's curse, and strawberry guava), trampling or collection by humans, and the small number of populations (USFWS 1991b).

f. Conservation Measures

The DLNR has weeded the Pahole NAR population and removed Koster's curse and Christmas berry (T. Takahama, personal communication 1995). DLNR also has plans to outplant this species at one of the Pahole NAR outplanting exclosures (B. Garnett, personal communication 1995).

g. Needed Recovery Actions

Below is a suggested species-specific recovery action. This action does not reflect the order in which it should be accomplished or take priority over any other recovery tasks. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

1) Conduct research on limiting factors, especially reproductive biology and pollination.

Hesperomannia arbuscula seeds are always empty and don't appear to develop fully. Reasons for this need to be investigated (J. Lau, personal communication 1995).

18. *Lipochaeta lobata* var. *leptophylla* - RP# 6

a. Description and Taxonomy

Suitable drawings depicting *Lipochaeta lobata* var. *leptophylla* are not available.

The earliest collection of *Lipochaeta lobata* var. *leptophylla* was made by Forbes in 1915, from which Degener and Sherff (Sherff 1933) described the taxon, giving it a varietal name that refers to its slender leaves.

Lipochaeta lobata var. *leptophylla*, a member of the aster family, is a low and somewhat woody perennial herb with arched or nearly prostrate stems which may be up to 59 inches (150 centimeters) long. Leaves of this variety are lance-shaped and closely spaced along the stem. Flower heads grow singly or in clusters of 2 or 3, each consisting of bracts (the involucre) usually 0.2 to 0.3 inches (5 to 8 millimeters) long beneath 8 to 15 yellow ray florets which surround 20 to 65 yellow disk florets. Fruits are achenes which measure 0.1 inches (2.5 to 2.7

millimeters) long by 0.04 to 0.06 inches (1.0 to 1.5 millimeters) wide. They have small wings about 0.2 inches (0.4 to 0.5 millimeters) long. This species is the only one of its genus on Oahu with four-parted disk florets except for a very rare coastal plant. This variety has narrower leaves spaced more closely along the stem than those of *L. obata* var. *lobata*, the only other variety of this species (USFWS 1991b, Wagner *et al*. 1990).

b. Life History

Flowering of *Lipochaeta lobata* var. *leptophylla* is probably rain-induced. There may be fewer distinct individuals in populations than it appears because a large portion of individuals are connected underground by the roots and are probably clones (J. Obata, personal communication 1995).

c. Habitat Description

Lipochaeta lobata var. *leptophylla* typically grows in dry shrubland at an elevation of 1,500 to 2,500 feet (460 to 760 meters) (USFWS 1991b). Associated species include ʻaʻaliʻi, ʻalaʻala wai nui, koa haole, and koʻokoʻolau (USFWS 1991b).

d. Historic and Current Range and Population Status

Historically, *Lipochaeta lobata* var. *leptophylla* was known from the southern Waianae Mountains, from Kolekole Pass to Lualualei (Wagner *et al*. 1990). This taxon remains on Lualualei-Nanakuli Ridge, Puu Hapapa, and Puu Kaua on Federal land (HHP 1994a). The 3 known populations, which are about 4.2 miles (6.7 kilometers) apart, contain about 100 individuals (HHP 1994a).

e. Reasons for Decline and Current Threats

The major threats to *Lipochaeta lobata* var. *leptophylla* are competition from alien plant species (Christmasberry, koa haole, and molasses grass), feral goats, fire, and the small number of extant individuals (USFWS 1991b).

f. Conservation Measures

No specific conservation measures are being conducted for *Lipochaeta lobata* var. *leptophylla* except those mentioned in the Overall Conservation Efforts section of this plan.

g. Needed Recovery Actions

There are no known species-specific recovery actions for this species at this time. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

19. *Lipochaeta tenuifolia* - RP# 8

a. Description and Taxonomy

Appendix E contains a line drawing of *Lipochaeta tenuifolia*.

Gray (1861) described *Lipochaeta tenuifolia* from specimens collected during the U.S. Exploring Expedition in 1840. The species epithet refers to the narrow leaflets of the three-parted, palmately compound leaves.

Lipochaeta tenuifolia, a member of the aster family, is a low growing, somewhat woody perennial herb with short, more or less erect branches. The stems are 10 feet (3 meters) long or longer and root along the lower surface. The oppositely arranged leaves are divided into three lobes so deeply that they appear to be six leaves; each lobe is divided to the midrib into fine segments. Flower heads are single or in clusters of two. The involucral bracts are 0.2 to 0.3 inches (5 to 7.5 millimeters) long. Ray florets, on the outer portion of the flower head, are yellow, number 8 to 10 per head, and measure 0.3 to 0.5 inches (8 to 11.5 millimeters) long. Disk florets, in the center of the flower head, are also yellow, number 20 to 30 per head, are 5-parted, and measure about 0.1 inches (2.7 to 3 millimeters) long. The fruits are bumpy achenes with tiny wings, and measure 0.07 to 0.09 inches (1.8 to 2.4 millimeters) long by 0.04 to 0.06 inches (1.1 to 1.5 millimeters) wide. Its five-parted disk florets and its deeply cut, stalkless leaves separate this species from other members of the genus (USFWS 1991b, Wagner *et al*. 1990).

b. Life History

Little is known about the life history of *Lipochaeta tenuifolia*. Flowering cycle, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown.

c. Habitat Description

Lipochaeta tenuifolia typically grows on ridgetops and bluffs in open areas and protected pockets of diverse mesic forest dominated by Christmasberry and 'ohi'a at an elevation of 1,200 to 3,000 feet (370 to 900 meters) (USFWS 1991b, Wagner *et al*. 1990). Associated species include ko'oko'olau, molasses grass, and *Ageratina riparia* (Hamakua pamakani), (USFWS 1991b).

d. Historic and Current Range and Population Status

Lipochaeta tenuifolia was known from the central Waianae Mountains (Wagner *et al*. 1990). It currently occurs from Kaluakauila Gulch to Kamaileunu Ridge, along Makua-Keaau Ridge, and Mt. Kaala on Federal and State-owned land (HHP 1994a, 1994b). The 8 known populations, which are located within an area of about 5 by 6 miles (8 by 10 kilometers), contain at least 2000 individuals (HHP 1994a, 1994b; S. Perlman, personal communication 1994).

e. Reasons for Decline and Current Threats

The major threats to *Lipochaeta tenuifolia* are habitat degradation by feral goats and pigs, competition for light and space from alien plant species (Christmasberry, koa haole, molasses grass, daisy fleabane, and strawberry guava), and fire (USFWS 1991b).

f. Conservation Measures

No specific conservation measures are being conducted for *Lipochaeta tenuifolia* except those mentioned in the Overall Conservation Efforts section of this plan.

g. Needed Recovery Actions

There are no known species-specific recovery actions for this species at this time. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

20. *Lobelia niihauensis* - RP# 8

a. Description and Taxonomy

Appendix E contains a line drawing of *Lobelia niihauensis*.

Lobelia niihauensis was described by St. John in 1931, based on a specimen he had collected on the island of Niihau (St. John 1931). Thomas G. Lammers (1990), in his revision of the genus, believed *L. niihauensis* to be conspecific with a Kauai plant previously published by Amos Arthur Heller and named *L. tortuosa* (Heller 1897). When Lammers combined the taxa he was required to use the name *niihauensis*. Although tortuosa is an older name, it had been given to another member of the genus by Carl Ernst Kuntze six years prior to Heller's publication. Other published names which refer to this taxon are: *L. niihauensis* var. *forbesii* (St. John 1939), *L. niihauensis* var. *meridiana* (St. John 1939), *L. tortuosa* f. *glabrata*, *L.* tortuosa var. *haupuensis* (St. John 1987b), and *L.* tortuosa var. *intermedia* (St. John 1939). In 1965, Otto and Isa Degener proposed a new genus to honor F.E. Wimmer, a distinguished student of the lobelia family. They later transferred 19 taxa to the new genus (Degener and Degener 1965). This genus has not been accepted by any other botanical authority. The synonyms resulting from this transfer which can be applied to *L. niihauensis* are *Neowimmeria niihauensis* and *N.* tortuosa (Degener and Degener 1965), as well as *N. intermedia*, *N. meridiana*, *N. niihauensis* var. *forbesii*, and *N.* tortuosa var. *glabrata* (Degener and Degener 1974).

Lobelia niihauensis, a member of the bellflower family, is a low, branched shrub. Each branch ends in a rosette of leaves, which are 2.8 to 5.9 inches (7 to 15 centimeters) long and 0.3 to 0.7 inches (0.7 to 1.8 centimeters) wide. Magenta flowers are clustered at the ends of branches and produce an egg-shaped capsule 0.2 to 0.3 inches (6 to 8 millimeters) long with many small brownish seeds. This species is distinguished from others in the genus by its leaves lacking or nearly lacking leaf stalks, the magenta-colored flowers, the width of the leaf, and length of the flower (USFWS 1991b).

b. Life History

Lobelia niihauensis flowers in late summer and early fall. Fruits mature a month to 6 weeks later. Plants are long-lived and are known to live as long as 20 years (J. Obata, personal communication 1995).

c. Habitat Description

Lobelia niihauensis typically grows on exposed mesic to dry cliffs at an elevation of 330 to 2,720 feet (100 to 830 meters) (USFWS 1991b). Associated species include daisy fleabane, kawelu, nehe, and *Artemisia* ('ahinahina) (USFWS 1991b).

d. Historic and Current Range and Population Status

Historically, *Lobelia niihauensis* was known from the Waianae Mountains of Oahu, from Uluhulu Gulch to Nanakuli Valley; from western Kauai, from Limahuli Valley to near the Hanapepe River as well as in the east at Nounou Mountain and the Haupu Range; and from the island of Niihau (USFWS 1991b). It is now known to be extant only on Kauai and Oahu. On Oahu, this species remains on Kamaileunu Ridge, Makaha-Waianae Kai Ridge, Makua-Keaau Ridge, Puu Kalena, Kaimokuiki Ridge, and in Nanakuli Valley, on Federal, State and private land (HHP 1994a, 1994b, 1994c). On Kauai, this species is found in Waimea Canyon, on Polihale Ridge, along the Na Pali Coast, and in the Haupu Range, on State and private land (HHP 1994a). The 33 known populations, which are located within an area of about 5 by 10 miles (8 by 16 kilometers) on Oahu and 8 by 10 miles (13 by 16 kilometers) on western Kauai, with the eastern Kauai population about 23 miles (37 kilometers) away, contain at least 2000 individuals (HHP 1994a, 1994b, 1994c; S. Perlman, personal communication 1994).

e. Reasons for Decline and Current Threats

On Oahu, the major threats to *Lobelia niihauensis* are trampling by feral pigs, habitat degradation and predation by feral goats, fire, competition from alien plant species

(Christmasberry, koa haole, and molasses grass), and trampling by humans on or along trails. On Kauai, the major threats are habitat degradation and predation by goats and competition from alien plant species (USFWS 1991b).

f. Conservation Measures

No specific conservation measures are being conducted for *Lobelia niihauensis* except those mentioned in the Overall Conservation Efforts section of this plan.

g. Needed Recovery Actions

There are no known species-specific recovery actions for this species at this time. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

21. *Neraudia angulata* - RP# 5

a. Description and Taxonomy

Appendix E contains a line drawing of *Neraudia angulata*.

On the basis of a 1912 collection by Forbes, Richard S. Cowan (1949) described *Neraudia angulata*, choosing the specific epithet in reference to the angled character of the mature calyx of the female flower. He and Degener (Cowan 1949) described var. *dentata*, which is closely sympatric with the nominative variety but is currently recognized as a distinct variety (Wagner *et al*. 1990).

Neraudia angulata, a member of the nettle family (Urticaceae), is an erect shrub to 10 feet (3 meters) tall. Leaves are thin and elliptic to oval in outline. They are 2.8 to 5.9 inches (7 to 15 centimeters) long and 1.2 to 2.2 inches (3 to 5.5 centimeters) wide. The upper leaf surface has a few silky hairs, and the lower surface is moderately hairy. Flowers are male or female and grow on different plants. The female flowers produce a dry-walled fruit which is surrounded by fleshy, fused sepals. This species is distinguished from other species in its genus by the conspicuously angled, ridged, fleshy calyx in the female flower (USFWS 1991b, Wagner *et al*. 1990).

b. Life History

Neraudia angulata flowers and fruits from early spring to summer. Fruits mature in about a month (J. Obata, personal communication 1995).

c. Habitat Description

Neraudia angulata typically grows on slopes, ledges, or gulches in diverse mesic forest dominated by lama, at an elevation of 1,200 to 2,700 feet (370 to 820 meters) (USFWS 1991b, Wagner *et al*. 1990). Associated species include aulu, Christmasberry, and *Nestegis sandwicensis* (olopua) (USFWS 1991b).

d. Historic and Current Range and Population Status

Historically, *Neraudia angulata* was known from almost the entire length of the Waianae Mountains, from Kaluakauila Gulch nearly to Puu Manawahua (USFWS 1991b, Wagner *et al*. 1990). This species is currently known from Kaluakauila Gulch along Makua-Keaau ridge to Makaha-Waianae Kai Ridge on Federal, State, and private land (HHP 1994a, 1994b, 1994c). The 15 known populations, which are located within an area of about 3 by 11 miles (4.8 by 18 kilometers), are estimated to comprise approximately 109 individuals (HHP 1994a, 1994b, 1994c).

e. Reasons for Decline and Current Threats

The major threats to *Neraudia angulata* are habitat degradation by feral goats and pigs, competition from alien plant species (Christmasberry, huehue haole, molasses grass, and strawberry guava), fire, and the small number of extant individuals (USFWS 1991b).

f. Conservation Measures

No specific conservation measures are being conducted for *Neraudia angulata* except those mentioned in the Overall Conservation Efforts section of this plan.

g. Needed Recovery Actions

There are no known species-specific recovery actions for this species at this time. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

22. *Nototrichium humile* - RP# 8

a. Description and Taxonomy

Appendix E contains a line drawing of *Nototrichium humile*.

Hillebrand (1888) discovered *Nototrichium humile* and named the genus for its "remarkable (Latin, *nota*) hairs (Greek, *tricho*)," that is, its extreme hairiness. The species epithet refers to the plant's low-growing habit. The species for a time was transferred to the genus *Psilotrichum* (Drake del Castillo 1892). Sherff (1950) recognized three varieties of this species based on leaf shape and size: var. *humile*, var. *parvifolium*, and var. *subrhomboideum*. These varieties were not accepted in the most recent treatment of the genus (Wagner *et al*. 1990).

Nototrichium humile, a member of the amaranth family (Amaranthaceae), is an upright to trailing shrub with branched stems to 5 feet (1.5 meters) long. Stems and young leaves are covered with short hairs. Leaves are oppositely arranged, oval to oblong in outline, 1.2 to 3.5 inches (3 to 9 centimeters) long, and 0.8 to 2.0 inches (2 to 5 centimeters) wide. Stalkless flowers are arranged in a spike 1.2 to 5.5 inches (3 to 14 centimeters) long and are at the ends of the stem. Membranous bracts grow below each flower. Two of the bracts and the sepals fall off with the mature fruit, which is 0.08 inches (2 millimeters) long. This species is distinguished from the only other species in the genus by its inflorescence, a slender spike 0.2 inches (4 millimeters) in diameter or less, which is covered with short hairs (USFWS 1991b, Wagner *et al*. 1990).

b. Life History

Nototrichium humile is found on and at the base of rock cliffs and talus slopes in areas that do not receive full sun all day. Plants have been observed flowering after heavy rain, but flowering is generally heaviest in the spring and summer. Fruits mature a few weeks after flowering (J. Obata, personal communication 1995). In cultivation, this species is known to live for decades (J. Lau, personal communication 1995).

c. Habitat Description

Nototrichium humile typically grows at an elevation of 200 to 2,300 feet (60 to 700 meters), on cliff faces, gulches, or steep slopes in remnants of open dry forests often dominated by aulu or lama (USFWS 1991b, Wagner *et al.* 1990). Associated species include Christmasberry, kukui, and olopua (USFWS 1991b).

d. Historic and Current Range and Population Status

Historically, *Nototrichium humile* was known from the entire length of the Waianae Mountains, from near Kaena Point to Nanakuli Valley, and from Lualailua Hills on East Maui (USFWS 1991b, Wagner *et al.* 1990). This species is still extant on Oahu from Kaluakauila Gulch along Makua-Keaau Ridge to Makaha-Waianae Kai Ridge and Nanakuli on Federal, State and private land (HHP 1994a, 1994b, 1994c; J. Lau, personal communication 1995). It is also extant in Maui's Lualailua Hills on private land (HHP 1994a). Fourteen of the 15 known populations grow within an area of about 3 by 11 miles (4.8 by 18 kilometers) in the Waianae Mountains, and, together with the Maui population, total an estimated 1,580 to 1,610 individuals (HHP 1994a, 1994b, 1994c).

e. Reasons for Decline and Current Threats

On both Oahu and East Maui, the major threats to *Nototrichium humile* are habitat degradation by feral goats, pigs, and cattle; competition from alien plant species (Christmasberry, koa haole, molasses grass, and strawberry guava); and fire (USFWS 1991b).

f. Conservation Measures

One individual of *Nototrichium humile* has been outplanted by TNC in a fenced exclosure in Honouliuli Preserve (B. Morgan, personal communication 1995).

g. Needed Recovery Actions

Below is a suggested species-specific recovery action. This action does not reflect the order in which it should be accomplished or take priority over any other recovery tasks. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

1) Special attention should be paid to the East Maui population because this population has not been checked in a long time (J. Lau, personal communication 1995).

23. ***Phyllostegia mollis*** - RP# 5

a. Description and Taxonomy

Appendix E contains a line drawing of *Phyllostegia mollis*.

Soon after erecting the genus *Phyllostegia*, George Bentham (1831) described *Phyllostegia mollis*, the specific epithet referring to its soft pubescence. Other published names that refer to this taxon are *P. haliakalae* (Wawra 1872), *P. honolulensis* (Wawra 1872), *P. parviflora* var. *honolulensis* (Sherff 1934c), and *P. parviflora* var. *mollis* (Gray 1861). Sherff's concept of *P. mollis* was broader than that accepted in the most recent treatment of the genus (Wagner *et al*. 1990), and many varieties he described are now referred to other species: var. *fagerlindii* (Sherff 1949), var. *hochreutineri* (Sherff 1953), and var. *skottsbergii* (Sherff 1939) are now included in *P. electra* (Forbes 1916); var. *micrantha* (Sherff 1934a) in *P. imminuta* (St. John 1976); var. *lydgatei* (Sherff 1934a) in *P. parviflora* (Bentham 1831); and var. *glabrescens* (Sherff 1952) in *P. stachyoides* (Gray 1861). Fosberg (1942) described *P. mollis* var. *resinosa* based on a specimen of *P. electra*. Most recently, St. John (1987a) published many species, varieties, and combinations in *Phyllostegia*; however, most botanists do not accept this treatment (Wagner *et al*. 1990).

Phyllostegia mollis, a member of the mint family (Lamiaceae), grows as a nearly erect, densely hairy, nonaromatic, perennial herb. Leaves are oval in outline with rounded teeth and usually are 3.9 to 9.4 inches (10 to 24 centimeters) long and 1.3 to 2.8 inches (3.3 to 7 centimeters) wide. Flowers, usually in groups of 6, are spaced along a stem 3.1 to 6.7 inches (8 to 17 centimeters) long; there are 2 shorter flowering stems directly below the main stem. The flowers have fused sepals which are 0.1 to 0.2 inches (3 to 4 millimeters) long and white petals 0.3 to 0.5 inches (8.5 to 12 millimeters) long fused into a tube and flaring into a smaller upper and a larger lower lip. Fruits are fleshy, dark green to black nutlets about 0.1 inches (2 to 3 millimeters) long. A suite of technical characters concerning the kind and amount of hair, the number of flowers in a cluster, and details of the various plant parts separate this species from other members of the genus (USFWS 1991b, Wagner *et al.* 1990).

b. Life History

Phyllostegia mollis flowers in the late winter and spring. Plants are relatively short-lived and live approximately five years (J. Obata, personal communication 1995).

c. Habitat Description

Phyllostegia mollis typically grows on steep slopes and in gulches in diverse mesic to wet forests at an elevation of 1,500 to 6,000 feet (450 to 1830 meters) (Wagner *et al.* 1990; USFWS 1991b). Associated plants include ferns, kopiko, *Pisonia* (papala kepau), and *Rubus* (raspberry) (USFWS 1991b).

d. Historic and Current Range and Population Status

Historically, *Phyllostegia mollis* was known from the central and southern Waianae Mountains, from Mt. Kaala to Honouliuli, and from Makiki in the Koolau Mountains of Oahu (USFWS 1991b, Wagner *et al.* 1990). It also was known from Molokai and East Maui (USFWS 1991b, Wagner *et al.* 1990). This species remains only in Kaluaa Gulch, Palikea, Puu Kumakili, and on Puu Kalena in the Waianae Mountains and in Waiopai Gulch on East Maui on Federal, State and private land (HHP 1994a, 1994c, USFWS 1991b). The 4 populations in the Waianae Mountains are 2.5 miles (4 kilometers) apart and are estimated to contain approximately 120 to 140 individuals (HHP 1994a, 1994c). Only one plant is still thought to be extant on East Maui (C. Corn, personal communication 1995).

e. Reasons for Decline and Current Threats

The major threats to *Phyllostegia mollis* are competition from the alien plant species (Christmasberry), feral pigs, and the small number of extant populations (USFWS 1991b).

f. Conservation Measures

No specific conservation measures are being conducted for *Phyllostegia mollis* except those mentioned in the Overall Conservation Efforts section of this plan.

g. Needed Recovery Actions

Below is a suggested species-specific recovery action. This action does not reflect the order in which it should be accomplished or take priority over any other recovery tasks. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

1) Further taxonomic research is needed to determine the genetic differences between the Oahu and Maui populations of this species (J. Lau, personal communication 1995).

24. *Sanicula mariversa* - RP# 5

a. Description and Taxonomy

Appendix E contains a line drawing of *Sanicula mariversa*.

Sanicula mariversa was discovered by Kenneth M. Nagata in 1981, who later described the species in a publication with Samuel M. Gon, III (Nagata and Gon 1987). The specific epithet refers to the plant's habitat which is on a ridge overlooking the sea.

Sanicula mariversa, a member of the parsley family (Apiaceae), is an upright herb, 16 to 28 inches (40 to 70 centimeters) tall which produces a single branched stem from a sturdy base (caudex) growing just beneath the surface of the soil. There are many heart- to kidney-shaped, leathery, 3- to 5-lobed leaves, 5 to 9 inches (13 to 23 centimeters) wide, growing from the base of the plant. Leaves on the stem become smaller and more deeply lobed the closer they are to the tip of the stem. Flowers are arranged in 1 to 4 more or less flat-topped clusters; each cluster comprises 10 to 20 flowers and is located at the end of the stem or in the leaf axils. Each flower cluster has 8 to 12 bracts beneath it and comprises both male and hermaphroditic flowers. There are 5 nearly circular, fused, toothed, yellow petals, each 0.04 inches (1 millimeters) wide. The egg-shaped fruit is about 0.2 inches (4 to 6 millimeters) long by about 0.1 inches (3 to 4 millimeters) wide, covered with hooked prickles, and separates into 2 single-seeded parts. The larger size of the plant and basal leaves, the color of the flower petals, and the hooked prickles on the fruit separate this species from others of the genus in Hawaii (USFWS 1991b).

b. Life History

Sanicula mariversa is known to flower from February through May, and fruits can be found until June (Nagata and Gon 1987).

c. Habitat Description

Sanicula mariversa typically grows on well-drained, dry slopes at an elevation of 2,500 to 2,800 feet (750 to 850 meters) (USFWS 1991b, Wagner *et al*. 1990). Associated species include Hamakua pamakani, kawelu, and 'ohi'a (USFWS 1991b).

d. Historic and Current Range and Population Status

Historically, *Sanicula mariversa* was known from the central Waianae Mountains, from Makua-Keaau Ridge to Kaluaa-Lualualei Summit Ridge (USFWS 1991b). This species is now extant only at Makua-Keaau Ridge on Federal and State-owned land (HHP 1994a, 1994b). The 2 known populations, which are about 0.4 miles (0.6 kilometers) apart, contain approximately 75 individuals (HHP 1994a, 1994b).

e. Reasons for Decline and Current Threats

The major threats to *Sanicula mariversa* are habitat degradation by feral goats, fire, competition from alien plant species (Christmasberry and molasses grass), trampling by humans on or near trails, and the small number of populations (USFWS 1991b).

f. Conservation Measures

No specific conservation measures are being conducted for *Sanicula mariversa* except those mentioned in the Overall Conservation Efforts section of this plan.

g. Needed Recovery Actions

Below is a suggested species-specific recovery action. This action does not reflect the order in which it should be accomplished or take priority over any other recovery tasks. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

1) Propagate and establish outplanted populations within areas protected from ungulates in former or suitable habitat. Erosion scars are eating away at the two known populations. Even if goats are removed, the populations will still be threatened by landslides. It would be possible to remove plants as they are about to be destroyed and transplant them elsewhere in a safer location (J. Lau, personal communication 1995).

25. ***Schiedea kaalae*** - RP# 5

a. Description and Taxonomy
Appendix E contains a line drawing of *Schiedea kaalae*.

In 1873 Wawra described *Schiedea kaalae* based upon a specimen he had collected three years earlier. The specific epithet refers to the geographical range of the plant, which is on the slopes of Mt. Kaala on Oahu. Sherff (1943) later recognized an additional variety, var. *acutifolia*, based upon a minor difference in the leaf. This variety is no longer accepted (Wagner *et al*. 1990).

Schiedea kaalae, a member of the pink family (Caryophyllaceae), has a short woody caudex less than 8 inches (20 centimeters) long. The thick, single-veined leaves are bunched at the top of the stem; they are long and elliptic or broader toward the tip and can reach a length of 9.4 inches (24 centimeters) and a width of 2.4 inches (6 centimeters). Flowers are in an open, much branched inflorescence (panicle) usually 8 to 16 inches (20 to 40 centimeters) long. The flowers lack petals, but have purple bracts and sepals, which are 0.1 to 0.2 inches (3 to 4 millimeters) long. Stamens and nectaries each number 5 and are about 0.2 inches (4 to 5 millimeters) long. Capsules are about 0.2 inches (4 millimeters) long, and seeds are dark grayish brown and about 0.04 inches (1 millimeters) long. This species can be distinguished from other members of its genus by its very short stems and its thick leaves with one conspicuous vein (USFWS 1991b, Wagner *et al*. 1990).

b. Life History

Schiedea kaalae is known to flower from March through June (Nagata 1980). In cultivation, however, it flowers throughout the year (J. Obata, personal communication 1995).

Although this species has virtually no genetic variability at allozyme loci, wild plants appear to be capable of self-fertilization and are producing seed. Seedlings are not apparent in wild populations and it is possible they are being eaten by herbivores such as slugs. Plants appear to be relatively long-lived, and in the greenhouse they are known to live about ten years (S. Weller, personal communication 1995).

c. Habitat Description

Schiedea kaalae typically grows on steep slopes and shaded sites in diverse mesic forests at an elevation of 700 to 2,600 feet (210 to 790 meters) (USFWS 1991b). Associated species include kukui, *Athyrium sandwicensis*, *Delissea subcordata*, and *Pisonia umbellifera* (papala kepau) (USFWS 1991b).

d. Historic and Current Range and Population Status

Historically, *Schiedea kaalae* is known from the north-central and south-central Waianae Mountains and the northern Koolau Mountains of Oahu (USFWS 1991b). This species remains on State and private lands at Pahole Gulch, Kaluaa Gulch, Pohakea Pass, and Puu Kaua in the Waianae Mountains and at Maakua Gulch and Makaua Stream in the Koolau Mountains (HHP 1994a; Wagner *et al*. 1990). The 4 known populations in the Waianae Mountains, which are distributed over an area of about 1 by 10 miles (1.6 by 16 kilometers), and the 2 known populations in the Koolau Mountains, which are about 4 miles (7 kilometers) apart, contain only 11 individuals (HHP 1994a).

e. Reasons for Decline and Current Threats

The major threats to *Schiedea kaalae* are habitat degradation by feral pigs and goats, competition from alien plant species (Christmasberry, pamakani, huehue haole, Koster's curse, molasses grass, and *Myrica faya* (firetree)), fire, and the small number of extant individuals (USFWS 1991b).

f. Conservation Measures

The DLNR has been monitoring and controlling feral pigs in the area around the Pahole Gulch population of *Schiedea kaalae*, and has plans to fence this population of five plants (T. Takahama, personal communication 1995).

Schieda kaalae is targeted for outplanting by DLNR at Pahole NAR, and there are six plants at the mid-elevation nursery at the Nike Site that are available for this outplanting (B. Garnett, personal communication 1995).

g. Needed Recovery Actions

Below is a suggested species-specific recovery action. This action does not reflect the order in which it should be accomplished or take priority over any other recovery tasks. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

1) Research limiting factors.
The possible impact of slugs on *Schieda kaalae* seedling recruitment should be investigated (S. Weller, personal communication 1995).

26. *Silene perlmanii* - RP# 5

a. Description and Taxonomy

Suitable drawings depicting *Silene perlmanii* are not available.

Steven Perlman and John Obata discovered *Silene perlmanii* in 1987. It was described by Warren L. Wagner, D. R. Herbst, and S. H. Sohmer (1989), and named in honor of one of its discoverers.

Silene perlmanii, a member of the pink family (Caryophyllaceae), is a perennial plant with stems that are woody at the base. It usually is much branched from the base and often forms clumps. Stems are 12 to 20 inches (30 to 50 centimeters) long, and leaves are in the shape of narrow ellipses 2 to 4 inches (5 to 10.5 centimeters) long and 0.3 to 0.6 inches (7 to 16 millimeters) wide. A few flowers are arranged in clusters at the ends of stems. Each flower has fused sepals 0.9 to 1.2 inches (22 to 30 millimeters) long with 5 lobes and white, deeply notched petals 0.3 to 0.4 inches (8 to 10 millimeters) long. Mature capsules have not been seen. It is the only species of the genus on Oahu and can be distinguished from other *Silene* species by its white petals and a calyx which is more than 0.7 inches (19 millimeters) long and densely covered with short hairs (USFWS 1991b, Wagner *et al*. 1990).

b. Life History

Silene perlmanii flowers in the spring, depending on climatic conditions. Flowers last for a day. Fruits develop in a few weeks (J. Obata, personal communication 1995).

c. Habitat Description

Silene perlmanii typically grows on cliff faces in diverse mesic forest at an elevation of 2,600 feet (790 meters) (USFWS 1991b, Wagner et *al*. 1990). Associated species include *Plantago princeps* (laukahi kuahiwi) (USFWS 1991b).

d. Historic and Current Range and Population Status

Silene perlmanii is known from the southern Waianae Mountains on Federal and privately owned land (USFWS 1991b, Wagner *et al*. 1990). No other localities are known for this recently discovered species (HHP 1994a). The 2 known populations, which are about 1 mile (1.6 kilometers) apart, contain 1 plant each at Palikea and Palawai Gulch (HHP 1994a; S. Perlman, personal communication 1994).

e. Reasons for Decline and Current Threats

The major threats to *Silene perlmanii* are competition from alien plant species (Christmasberry, firetree, and molasses grass), feral pigs, and the small number of extant individuals (USFWS 1991b).

f. Conservation Measures

No specific conservation measures are being conducted for *Silene perlmanii* except those mentioned in the Overall Conservation Efforts section of this plan.

g. Needed Recovery Actions

Below is a suggested species-specific recovery action. This action does not reflect the order in which it should be accomplished or take priority over any other recovery tasks. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

1) Control feral pigs.
Feral pigs don't directly impact this species, but they are responsible for general habitat degradation (J. Lau, personal communication 1995).

27. ***Stenogyne kanehoana*** - RP# 5

a. Description and Taxonomy

Appendix E contains a line drawing of *Stenogyne kanehoana*.

Stenogyne kanehoana was first collected on the east ridge of Puu Kanehoa, Waianae Mountains, by Harold St. John in 1934. Otto Degener collected it in the same area in 1939, and, along with Earl Sherff, described the taxon, naming it after the type locality. All subsequent collections have been from the same area which is near the summit of the ridge connecting Puu Kanehoa with Puu Hapapa to the north and Puu Kaua to the south, a distance totaling approximately 1.75 miles (2.8 kilometers) (USFWS 1992).

Stenogyne kanehoana is a scandent vine in the mint family (Lamiaceae) with stems weakly 4-angled, hairy, and 3 to 6 feet (1 to 2 meters) long. The leaves are oppositely arranged and are narrowly ovate to oblong-ovate, thin but densely hairy, about 4 inches (10 centimeters) long and 1.5 inches (3.5 centimeters) wide. The flowers are in clusters of 3 to 6 per leaf axil; the petals are fused into a strongly curved tube about 1 to 1.5 inches (2.7 to 4.2 centimeters) long, white or pale yellow with short, pink, corolla lobes. The fruit consists of 4 fleshy, black, nutlets (USFWS 1992). *Stenogyne kanehoana* is distinguished from the only other member of the genus occurring on Oahu, *S. kaalae*, primarily by the size and color of its flowers. The flowers of *S. kanehoana* are large, white to yellow, and tipped in pink, while those of *S. kaalae* are small and deep purple. *Stenogyne kanehoana* occurs on an open ridge top in mesic forest. Associated species include o'hi'a (*Metrosideros polymorpha*), koa (*Acacia koa*), 'ie'ie (*Freycinetia arborea*), and uluhe (*Dicranopteris linearis*) (USFWS 1992).

b. Life History

Stenogyne kanehoana generally flowers from February through March, but flowering depends on precipitation and flowers have been noted from January to as late as April. Fruits mature within 6 weeks. The life span of this species appears to be about 7-12 years (J. Obata, personal communication 1995).

c. Habitat Description

Stenogyne kanehoana occurs in one population consisting of two plants under a canopy of mesic forest trees on a ridge leading to the summit of Puu Kanehoa (USFWS 1992).

d. Historic and Current Range and Population Status

Stenogyne kanehoana is known from the east ridge of Puu Kanehoa, Waianae Mountains, near the summit of the ridge connecting Puu Kanehoa with Puu Hapapa to the north and Puu Kaua to the south, a distance totaling approximately 1.75 miles (2.8 kilometers). Today one population consisting of two plants remains under a canopy of mesic forest trees on a ridge leading to the summit of Puu Kanehoa (HHP 1994a; USFWS 1992). The plants occur on privately owned land.

e. Reasons for Decline and Current Threats

The greatest immediate threat to the survival of *Stenogyne kanehoana* is habitat degradation and competition for space, water, light, and nutrients by naturalized, alien vegetation (especially Koster's curse). The extremely small number of individual plants and their restricted distribution increases the potential for extinction from stochastic events. The limited gene pool may depress reproductive vigor, or a single man-caused or natural environmental disturbance could destroy all known individuals. Other potential threats which have been suggested include fire and deforestation, but, at present, these probably are not serious threats to the species (USFWS 1992). Feral pigs and hikers are also thought to be a threat to this species (Tanya Rubenstein, USFWS, personal communication 1995).

f. Conservation Measures

One attempt has been made to propagate *Stenogyne kanehoana* from seed and it was unsuccessful. Propagation from seed has not been attempted in recent years because no seeds have been available (J. Obata, personal communication 1995). Lyon Arboretum has sucessfully propagated this taxon from cuttings (see Table 3).

g. Needed Recovery Actions

Below are some suggested species-specific recovery actions. These actions do not reflect the order in which they should be accomplished or take priority over any other recovery tasks, unless indicated. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

1) Consider shifting trail slightly away from population to avoid threats of inadvertent trampling or cutting of plants by hikers.

2) Monitor remaining wild plants for changes in status and threats and implement management actions to protect, if necessary.

Although the plants are surrounded by Koster's curse, weeding would be extremely difficult and is likely to harm the remaining individuals. Any weeding of Koster's curse or other alien plants should be carefully assessed and done only if determined to be absolutely necessary.

The leafhopper threatens surrounding native and alien vegetation and could be a direct or indirect threat to the remaining *Stenogyne kanehoana*.

3) Monitor remaining wild plants for changes in reproductive status, and collect seeds for ex-situ propagation if fruits are produced.

4) Continue to develop propagation techniques for cuttings and support research to refine these techniques.

28. ***Tetramolopium filiforme*** - RP# 2

a. Description and Taxonomy

Appendix E contains a line drawing of *Tetramolopium filiforme*.

Tetramolopium filiforme was collected by Hillebrand in 1869 and described by Sherff (1934b) in his monograph of the genus. Sherff named the species *filiforme* because of its very narrow leaves. In the same monograph, Sherff described *Tetramolopium polyphyllum* based upon a plant collected by Wawra in 1870 during the Austrian East Asian Exploring Expedition. In a recent revision of the genus, Timothy K. Lowrey (1986, 1990) recognized *T. polyphyllum* as a variety of *T. filiforme*.

Tetramolopium filiforme, a member of the aster family, is a dwarf shrub from 2 to 6 inches (5 to 15 centimeters) tall with complexly branched stems. Leaves are much longer than wide, from 0.4 to 0.8 inches (1 to 2 centimeters) long and 0.02 to 0.05 inches (0.4 to 1.2 millimeters) wide. Flower heads are single or grouped in clusters of 2 to 4, each having a bell-shaped involucre 0.2 inches (4 to 5 millimeters) high and 0.3 to 0.4 inches (7 to 10 millimeters) in diameter. There are 35 to 52 white or pale lavender ray florets in a single circle at the edge of the head, each 0.1 to 0.2 inches (3 to 4 millimeters) long. There are 18 to 30 maroon (rarely yellow) disk florets in the center of each head. The ray florets are female, while the disk florets function as male flowers. Fruits are achenes, less than 0.1 inches (3 millimeters) long and up to 0.04 inches (1 millimeter) wide. This species is distinguished from the other extant species on Oahu by its separate male and female flowers both on the same plant, and its inflorescence of one to four heads (USFWS 1991b).

b. Life History

In cultivation, *Tetramolopium filiforme* germinates in about three weeks. Fifteen weeks after germination, the plants are approximately 3.5 inches (9 centimeters) high and they produce their first buds. The first blossoms are noted about eighteen weeks after germination. During growth an inflorescence forms at the apex of each shoot while new shoots develop laterally (Obata 1976).

Tetramolopium filiforme is relatively short-lived and usually lives less than five years. In the wild it usually flowers in the late winter or spring but flowering can also be induced by heavy rainfall (J. Obata, personal communication 1995).

c. Habitat Description

Tetramolopium filiforme typically grows on dry cliff faces and ridges at an elevation of 1,100 to 3,000 feet (340 to 900 meters) (USFWS 1991b). Associated species include 'a'ali'i, *Artemisia australis* ('ahinahina), and *Schiedea mannii* (USFWS 1991b).

d. Historic and Current Range and Population Status

Historically, *Tetramolopium filiforme* was known from the northern Waianae Mountains, from Ohikilolo Ridge, Keaau Valley, and Makaha Valley (USFWS 1991b, Lowrey 1990). This species remains in Keaau Valley, Kahanahaiki Valley, Puu Kawiwi, and on Makua-Keaau Ridge on Federal and State land (HHP 1994a, 1994b). The 4 known populations, which are distributed over an area of about 2 by 5 miles (3.2 by 8 kilometers), are estimated to contain approximately 1500 individuals (HHP 1994a, 1994b).

e. Reasons for Decline and Current Threats

The major threats to *Tetramolopium filiforme* are habitat degradation by feral goats, competition from alien plant species (Christmasberry, koa haole, molasses grass, and *Erigeron karvinskianus* (daisy fleabane)), fire, and trampling or collection by humans on or near trails (USFWS 1991b).

f. Conservation Measures

No specific conservation measures are being conducted for *Tetramolopium filiforme* except those mentioned in the Overall Conservation Efforts section of this plan.

g. Needed Recovery Actions

Below is a suggested species-specific recovery action. This action does not reflect the order in which it should be accomplished or take priority over any other recovery tasks. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

1) Conduct research on the genetic distinctiveness of the two varieties (J. Lau, personal communication 1995).

29. *Tetramolopium lepidotum* ssp. *lepidotum* - RP# 2

a. Description and Taxonomy

Appendix E contains a line drawing of *Tetramolopium lepidotum* spp. *lepidotum*.

Two subspecies of *Tetramolopium lepidotum* are recognized: subsp. *arbusculum*; and subsp. *lepidotum*. Subspecies *arbusculum* is known only from the type specimen and is probably extinct (Wagner et al. 1990). Subspecies *lepidotum* was described by Sherff (1934b) in his monograph of the genus. Other names which have been applied to this taxon are *Erigeron lepidotus* (Lessing 1831), *E. pauciflorus* (Hooker and Arnott 1830-1841), *E. tenerrimus* var. *lepidotus* (Drake del Castillo 1888), *T. chamissonis* var. *luxurians*

(Hillebrand 1888), *T. lepidotum* var. *luxurians* (Sherff 1934b), and *Vittadinia chamissonis* (Gray 1861).

Tetramolopium lepidotum ssp. *lepidotum*, a member of the aster family, is an erect shrub 4.7 to 14 inches (12 to 36 centimeters) tall, branching near the ends of the stems. Leaves of this taxon are lance-shaped, wider at the leaf tip, and measure 1.0 to 1.8 inches (25 to 45 millimeters) long and 0.04 to 0.3 inches (1 to 7 millimeters) wide. Flower heads are arranged in groups of 6 to 12. The involucre is bell-shaped and less than 0.2 inches (4 millimeters) high. Florets are either female or bisexual, with both occurring on the same plant. There are 21 to 40 white to pinkish lavender ray florets 0.04 to 0.08 inches (1 to 2 millimeters) long on the periphery of each head. In the center of each head there are 4 to 11 maroon to pale salmon disk florets. The fruits are achenes, 0.06 to 0.1 inches (1.6 to 2.5 millimeters) long and 0.02 to 0.03 in (0.5 to 0.8 millimeters) wide. This taxon can be distinguished from the other extant species on Oahu by its hermaphroditic disk flowers and its inflorescence of 6 to 12 heads (USFWS 1991b).

b. Life History

Tetramolopium lepidotum ssp. *lepidotum* is a short-lived perennial. Flowering cycle, pollination vectors, seed dispersal agents, specific environmental requirements, and limiting factors are unknown.

c. Habitat Description

Tetramolopium lepidotum ssp. *lepidotum* typically grows on grassy ridgetops, slopes, or west-facing cliffs in mesic forest at an elevation of 1,200 to 3,100 feet (370 to 940 meters) (USFWS 1991b). Associated species include daisy fleabane, firetree, ko'oko'olau, and 'ohi'a (USFWS 1991b).

d. Historic and Current Range and Population Status

Historically, *Tetramolopium lepidotum* ssp. *lepidotum* was known from nearly the entire length of the Waianae Mountains, from Makua Valley to Kaaikukui Ridge, as well as from the island of Lanai (USFWS 1991b, Lowrey 1990). This taxon remains on Federal, State, and privately-owned land on Kuma Kakii (2-3 individuals), Waianae Kai (2 individuals), and Puu Kaua (40-60 individuals) (HHP 1994a, 1994b, 1994c; S. Perlman, personal communication 1994). It also has 2 populations, of approximately 50 plants, on Hawaii at the Pohakuloa Training Center (L. Mehroff, personal communication 1994). This is a total of 5 populations and 94-115 individual plants.

e. Reasons for Decline and Current Threats

The major threats to *Tetramolopium lepidotum* ssp. *lepidotum* are competition from alien plant species (Christmasberry, fountaingrass, daisy fleabane, firetree, and molasses grass), goats, sheep, pigs, fire, trampling or collection by humans on or along trails, and the small number of populations (USFWS 1991b).

f. Conservation Measures

TNC has outplanted 2 individuals in a fenced exclosure (B. Morgan, personal communication 1995).

g. Needed Recovery Actions

There are no known species-specific recovery actions for this species at this time. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

30. ***Urera kaalae*** - RP# 5

a. Description and Taxonomy

Appendix E contains a line drawing of *Urera kaalae*.

Urera kaalae was first collected by Chamisso in the early 1800s, and later rediscovered and described by Wawra (1874). The specific epithet refers to the geographical range of the species.

Urera kaalae, a member of the nettle family (Urticaceae), is a small tree or shrub 10 to 23 feet (3 to 7 meters) tall. The sap of the plant becomes greenish black when exposed to air. Leaves are pale green, thin and membranous, heart-shaped, 4 to 11 inches (10 to 27 centimeters) long by 2 to 5 inches (5 to 13 centimeters) wide, with 3 main veins and toothed margins. Flowers are either male or female and may grow on the same or different plants. They are arranged in three-branched inflorescences. Sepals of male flowers are fused into rather globe-shaped structures about 0.06 inches (1.5 millimeters) long. Sepals of female flowers are less than 0.04 inches (1 millimeter) long, and the inner pair becomes slightly fleshy to enclose the achene along about half of its 0.04 inches (1 millimeter) length (USFWS 1991b, Wagner *et al*. 1990). This species can be distinguished from the other Hawaiian species of the genus by its heart-shaped leaves.

b. Life History

Urera kaalae has been observed flowering in the spring. It is difficult to predict when seeds will be produced, and, when they are produced, they are often sterile. This may be an indication of pollinator limitation. Plants are fast-growing (J. Obata, personal communication 1995).

c. Habitat Description

Urera kaalae typically grows on slopes and in gulches in diverse mesic forest dominated by papala kepau at an elevation of 980 to 2,700 feet (300 to 820 meters) (USFWS 1991b, Wagner *et al*. 1990). Associated species include huehue haole, mamaki, and *Psidium guajava* (guava) (USFWS 1991b).

d. Historic and Current Range and Population Status

Historically, *Urera kaalae* was known from the central to southern windward Waianae Mountains, from Waianae Uka to Kupehau Gulch (USFWS 1991b, Wagner *et al*. 1990). This species now occurs only in Ekahanui, Pualii, Napepeiauolelo, Halona, and Kaluaa gulches, Palawai, and Waianae Kai on Federal, State, and privately owned land (HHP 1994a, 1994c). The 9 known populations, which are sparsely distributed over an area of about 2.5 by 7 miles (4 by 11.2 kilometers), contain approximately 40 individuals (HHP 1994a, 1994c).

e. Reasons for Decline and Current Threats

The major threats to *Urera kaalae* are habitat degradation by feral pigs, competition from alien plant species (Christmasberry, daisy fleabane, firetree, huehue haole, molasses grass, and strawberry guava), fire, and the small number of extant individuals (USFWS 1991b).

f. Conservation Measures

TNC has outplanted 3 individuals in a fenced exclosure in Honouliuli Preserve and is monitoring their survival (B. Morgan, personal communication 1995). TNC has also recently searched for populations in Kaluaa and South Ekahanui gulches to monitor and conduct threat management but was only able to locate isolated individual plants (B. Morgan, personal communication 1995).

g. Needed Recovery Actions

There are no known species-specific recovery actions for this species at this time. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

31. *Viola chamissoniana* spp. *chamissoniana* - RP# 3

a. Description and Taxonomy

Appendix E contains a line drawing of *Viola chamissoniana* spp. *chamissoniana*.

First collected in 1817 by Johann Friedrick Eschscholz, surgeon on a Russian world exploring expedition, *Viola chamissoniana* was named by Gingins (1826) in honor of Chamisso, the botanist on the expedition. The name *V. chamissoniana* as used by Hillebrand (1888) included the taxon presently known as *V. chamissoniana* ssp. *tracheliifolia*; his *V. helioscopia* is now referred to as ssp. *chamissoniana* (Wagner et al. 1990).

Viola chamissoniana ssp. *chamissoniana*, a member of the violet family (Violaceae), is a branched shrub up to 3 feet (90 centimeters) tall. The toothed leaves, usually clustered at branch tips, are triangular-oval to heart-shaped in outline and measure about 0.8 to 1.6 inches (2 to 4 centimeters) long. Each flowering stalk produces 1 or 2 flowers with 5 sepals which are 0.2 to 0.4 inches (5 to 9 millimeters) long and 5 white, purple-tinged petals which are 0.4 to 0.9 inches (10 to 23 millimeters) long. Capsules are usually 0.5 to 0.7 inches (12 to 17 millimeters) long and contain dark brown to almost black seeds which are about 0.1 inches (1.8 to 2.3 millimeters) long. This subspecies can be distinguished from the other members of the genus in the Waianae Mountains by the small size of its leaves (USFWS 1991b, Wagner *et al.* 1990).

b. Life History

Viola chamissoniana ssp. *chamissoniana* has been observed flowering during the spring (J. Obata, personal communication 1995). Otherwise, little is known about its life history. Flowering cycle, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown.

c. Habitat Description

Viola chamissoniana ssp. *chamissoniana* typically grows on dry cliffs in mesic shrubland at an elevation of 2,300 to 3,040 feet (700 to 1,000 meters) (USFWS 1991b). Associated species include 'ahinahina, ko'oko'olau, and 'ohi'a (USFWS 1991b).

d. Historic and Current Range and Population Status

Historically, *Viola chamissoniana* ssp. *chamissoniana* was known from the central and southern Waianae Mountains, from Makaleha Valley to Kaaikukui (USFWS 1991b). This taxon now occurs on Kamaileunu Ridge, Palikea Ridge (between Nanakuli and Lualualei), Puu Hapapa, Makua-Keaau Ridge, Halona, and Puu Kumakalii on Federal and City/County land (HHP 1994a, 1994b, 1994c). The 6 known populations, which are scattered over an area of about 2.5 by 8.5 miles (4 by 13.6 kilometers), contain 237 individuals (HHP 1994a, 1994b, 1994c).

e. Reasons for Decline and Current Threats

The major threats to *Viola chamissoniana* ssp. *chamissoniana* are habitat degradation by feral goats and pigs; competition from the alien plant species (Christmasberry, daisy fleabane, pamakani, and molasses grass); fire; and the small number of extant individuals.

f. Conservation Measures

No specific conservation measures are being conducted for *Viola chamissoniana* ssp. *chamissoniana* except those mentioned in the Overall Conservation Efforts section of this plan.

g. Needed Recovery Actions

Below is a suggested species-specific recovery action. This action does not reflect the order in which it should be accomplished or take priority over any other recovery tasks. Please refer to the Stepdown Narrative section of this plan for the overall recovery strategy.

1) Conduct research on the genetic distinctiveness and relationship to *Viola chamissoniana* ssp. *tracheliifolia* (J. Lau, personal communication 1995).

H. Recovery Strategy

The plan for recovery, which is detailed in the following step-down narrative, begins with the protection and management of current habitats of the taxa. Current threats to the species are addressed through fencing and/or hunting to control ungulates; control of alien plants; protection from fire; control of rodents, insects, and disease; protection from human disturbance; collection, storage, and maintenance of genetic material; and, a comprehensive monitoring program. A research program is also recommended to distinguish between similar taxa, study the growth and reproductive viability of each taxon, determine the parameters of viable populations of each taxon, study possible pests and diseases, and use the results of such research to improve management practices.

A program of augmentation of very small populations and reestablishment of new populations within the historical range of the species is also needed. This includes selection of areas for augmentation and reestablishment, determination of the best methods for *ex situ* propagation and transplanting, selection of the best genetic stock for each area, propagation of suitable stock, preparation of sites for seeding and/or transplanting, and monitoring and maintenance of new individuals and populations as they are established.

Finally, the recovery objectives should be refined and revised as new information becomes available.

PART II. RECOVERY

1. Objectives

Objectives for stabilizing, downlisting, and delisting are provided for the Waianae plant cluster taxa. The order of tasks listed in the step-down outline and narrative does not necessarily designate the order in which these tasks should be implemented. Priorities for action and recommended time-frames are contained in the Implementation Schedule of this plan.

An endangered species is defined in section 3 of the Endangered Species Act as any species which is in danger of extinction throughout all or a significant portion of its range. A threatened species is defined as any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

For the purposes of this section, a population is defined as a discrete unit with sufficient distance between neighboring populations that the two are not affected by the same small-scale events (such as a landslide), and are not believed to be cross-pollinated. Mature individuals are defined as those either known or believed to be capable of reproduction. In general, long-lived perennials are those taxa either known or believed to have life spans greater than 10 years; short-lived perennials are those known or believed to have life spans greater than one year but less than 10 years.

The long-lived perennials in this plan are: *Hesperomannia arbuscula* and *Urera kaalae*.

The short-lived perennials in this plan are: *Abutilon sandwicense, Alsinidendron obovatum, Alsinidendron trinerve, Centaurium sebaeoides, Chamaesyce celastroides* var. *kaena, Chamaesyce kuwaleana, Cyanea grimesiana* ssp. *obatae, Cyanea pinnatifida, Cyanea superba, Diellia falcata, Diellia unisora, Dubautia herbstobatae, Gounia meyenii, Gounia vitifolia, Hedyotis degeneri, Hedyotis parvula, Lipochaeta lobata* var. *leptophylla, Lipochaeta tenuifolia, Lobelia niihauensis, Neraudia angulata, Nototrichium humile, Phyllostegia mollis, Sanicula mariversa, Schiedea kaalae, Silene perlmanii, Stenogyne kanehoana, Tetramolopium filiforme, Tetramolopium lepidotum* ssp. *lepidotum, Viola chamissoniana* ssp. *chamissoniana*.

Because we have only limited knowledge of the life history of each of these taxa with respect to specific requirements for their short-term and long-term survival, only tentative criteria for stabilizing, downlisting, and delisting are established here. These criteria were formulated based on recommendations by the Hawaii and Pacific Plants Recovery Coordinating Committee, as well as the International Union for Conservation of Nature and Natural Resources' (IUCN's) draft red list categories (Version 2.2) and the advice and recommendations of various biologists and knowledgeable individuals.

Additional information is needed about each of the Waianae cluster taxa so that more meaningful recovery objectives can be quantified.

Interim Objectives

The interim objective is to stabilize all existing populations of the Waianae taxa. To be considered stable, each taxon must be managed to control threats (e.g., fenced) and be represented in an *ex situ* collection. In addition, a minimum total of three (3) populations of each taxon should be documented on Oahu, and, if possible, at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing and increasing in number, with a minimum of 25 mature individuals per population for long-lived perennials and a minimum of 50 mature individuals per population for short-lived perennials.

Downlisting Objectives

For downlisting, a total of five to seven (5-7) populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. In certain cases, however, a particular taxon may be eligible for downlisting even if all five to seven (5-7) of the populations are on only one island, provided all of the other recovery criteria have been met and the populations in question are widely distributed and secure enough that one might reasonably conclude that the taxon is not in danger of extinction throughout all or a significant part of its range.

Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered.

Delisting Objectives

A total of eight to ten (8-10) populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. As with downlisting, there may be cases in which a particular taxon may be eligible for delisting even if all eight to ten (8-10) of the populations are on only one island, provided all of the other recovery criteria have been met and the populations in question are widely distributed and secure enough that one might reasonably conclude that the taxon is not likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years.

2. Stepdown Outline

1. Protect and manage current populations and their habitat.
    11. Identify and map all extant wild populations.
    12. Identify management units for preservation.
    13. Provide long-term security for each management unit.
        131. Provide long-term security for Federal Lands.
        132. Provide long-term security for State of Hawaii lands.
        133. Provide long-term security for all other lands.
    14. Develop management plans for each unit.
    15. Implement management plans.
        151. Control introduced ungulates.
            1511. Determine fencing strategy.
            1512. Construct and maintain fencing.
            1513. Remove ungulates within fenced areas.
            1514. Monitor fenced areas for ungulate damage and effects on weeds.
            1515. Consider control of ungulates through eradication programs.
        152. Conduct essential alien plant control.
            1521. Determine effective control methods.
            1522. Implement weed control.
            1523. Prevent introduction of new alien species to Hawaii.
        153. Provide necessary fire protection.
            1531. Develop fire protection plans.
            1532. Implement fire protection plans.
        154. Control other introduced animals.
            1541. Control rodents.
            1542. Control slugs, as needed.
            1543. Control insects, as needed.
        155. Control disease, if necessary.
        156. Ensure availability of pollination vectors.

        157. Protect areas from direct/indirect threats from humans.

        158. Monitor status of wild populations.

        159. Maintain genetic stock *ex situ*.

2. Conduct essential research.

    21. Collect diagnostic data on crucial associated ecosystem components.

    22. Map alien vegetation.

    23. Study various aspects of growth.

    24. Study reproductive viability.

    25. Determine parameters of viable populations.

    26. Determine genetic distinctiveness.

    27. Determine the kind and degree of threat posed by selected diseases/introduced species.

        271. Determine threat posed by rodents.

        272. Determine threat posed by slugs.

        273. Determine threat posed by insects.

        274. Determine threat of diseases or other introduced species.

    28. Determine effective control methods to combat selected diseases/introduced species.

        281. Determine control methods for rodents.

        282. Determine control methods for slugs.

        283. Determine control methods insects.

        284. Other control methods for diseases and other introduced species.

    29. Evaluate results and use in future management.

3. Expand existing wild populations.

    31. Develop plans for expansion of each population, when necessary.

        311. Identify sites for expansion.

        312. Identify material to be used for expansion.

        313. Determine optimum propagation methods.

        314. Determine appropriate augmentation methods.

32. Implement expansion plans.

    321. Propagate *ex situ*.

    322. Prepare sites.

    323. Plant.

    324. Monitor and maintain new individuals.

4. Reestablish wild populations within the historic range.

    41. Investigate feasibility and desirability of reintroduction.

    42. Develop specific plans for reestablishment.

        421. Identify sites for reestablishment.

            4211. Identify reestablishment sites on Oahu.

            422. Identify reestablishment sites on other islands.

        422. Identify material to be used for reestablishment.

    43. Implement reestablishment plans.

        431. Protect reestablishment sites.

        432. Manage reestablishment sites.

        433. Plant.

        434. Monitor and maintain new populations.

5. Validate recovery objectives.

    51. Determine the number of individuals needed for long-term survival.

    52. Determine the number of populations needed for long-term survival.

    53. Refine/revise downlisting and delisting criteria.

3. Stepdown Narrative

1. Protect and manage current populations and their habitat.

Given the degraded nature of the Waianae Recovery Plan taxa's habitat, their precariously low numbers, and the severity of the threats acting upon these taxa, the highest priority actions to be carried out immediately for these taxa must be aimed at protecting those individuals and populations that currently exist and managing their habitat to control the threats affecting their survival. Protection and management are most urgent for those 10 taxa nearest extinction: *Alsinidendron obovatum*, *Alsinidendron trinerve*, *Cyanea grimesiana* ssp. *obatae*, *Cyanea pinnatifida*, *Cyanea superba*, *Gouania vitifolia*, *Hedyotis degeneri*, *Schiedea kaalae*, *Silene perlmanii*, *Stenogyne kanehoana*.

11. Identify and map all extant wild populations.

Protection of the extant populations will involve first locating all extant individuals, mapping their precise locations, and providing this information to the land managers so that they may establish management units for the taxa on their lands.

Surveys of all reported and possible occurrences of each taxon should be conducted. Occurrence data, including presence in or absence from previously-reported sites (as well as site notes) and all relevant information for newly reported occurrences, should be carefully documented. Detailed site information (including directions, maps, global positioning system (GPS) data, and narratives) is recommended for each site. Specific areas for search are detailed in the species accounts for *Abutilon sandwicense*, *Centaurium sebaeoides*, and *Nototrichium humile*.

12. Identify management units for preservation.

Management units which, ideally, contain multiple populations of multiple species and can be managed under a single, coordinated, management plan must be identified for the 31 taxa in this recovery plan. These sites should include areas adequate for buffer zones and fire breaks and for expansion of existing populations and establishment of new populations for recovery. Similar areas around each newly-discovered population of each taxon should be identified and targeted for protection and management. The Hawaii and Pacific Plant Recovery Coordinating Committee and Plant Recovery Teams will assist the USFWS, DLNR, and other landowners and managers in identifying these management units.

13. Provide long-term security for each management unit.

In order to ensure maximum protection for the Waianae Recovery Plan taxa, it is essential to develop long-term management agreements which promote cooperation among landowners for planned conservation efforts. Long-term management agreements should be arranged for as much habitat as possible for each taxon.

131. Provide long-term security for Federal Lands.

Waianae Recovery Plan taxa on federal land are located on portions of Schofield Barracks and Makua Military Reservation (both under the jurisdiction of the U.S. Army) and Lualualei (under the jurisdiction of the U.S. Navy). The U.S. Army and Navy are required by section 7 of the Act to insure that any action authorized, funded, or carried out by them is not likely to jeopardize the continued existence of any endangered or threatened species. Section 7 further stipulates that all federal agencies utilize their authorities in furtherance of the purposes of the Act by carrying out programs for the conservation of listed species. The Army and Navy should be encouraged to develop and implement Endangered Species Management Plans and undergo section 7 consultation with the USFWS for any actions likely to affect the Waianae Recovery Plan taxa on their lands.

132. Provide long-term security for State of Hawaii lands.

The State of Hawaii should ensure that all departments within the State that are responsible for activities on these lands, such as land zoning, development projects, forestry projects, recreational programs, etc., are made aware of the presence of these listed plant taxa. In addition, the State should take steps to establish procedures to ensure that all State activities contemplated in the area are reviewed with respect to their potential impact on the listed plant taxa, with appropriate measures taken to minimize or preclude all negative impacts.

133. Provide long-term security for all other lands.

The remaining habitat is owned or managed by The Nature Conservancy, Campbell Estate, Castle and Cooke, Wailuku Agribusiness, Mokuleia Land Co., the City and County of Honolulu, and various private individuals. Steps should be taken to ensure that all such landowners are aware of the presence of the listed taxa on their lands and every effort should be made by the State Department of Forestry and Wildlife and/or the USFWS to assist the landowners, as necessary, in developing and implementing long-term management plans for those lands.

14. Develop management plans for each unit.

Development of management plans for each unit should be carried out in as cooperative a manner as possible, with every attempt made to enter into partnerships with landowners on whose lands the plants may occur and whose lands lie adjacent to management units. Management plans should be as all-encompassing as possible, incorporating several management units into one overall plan for restoration and management of the habitat which supports the 31 taxa identified in this recovery plan, along with other native components.

15. Implement management plans.

Among the actions that must be included in all, or the majority of, the management plans for these 31 taxa are actions needed to immediately protect the plants from grazing and trampling by introduced ungulates, competition from alien plants, and fire. Other actions that may be specific to certain taxa and management units only are: protection from other introduced species, such as insects and rodents, and protection from disease and nearby human use.

151. Control introduced ungulates.

The numbers of goats, pigs, cattle, and other introduced ungulates in the forests of Hawaii are extensive. Controlling these ungulates to the point where they are no longer impacting native vegetation is absolutely imperative. Most of the taxa included in this plan can not afford to wait many years for protection from ungulates.

The most effective method currently known for providing immediate protection from introduced ungulates in Hawaii is fencing of discrete management units. Although this approach is costly, it does work, as demonstrated at Hawaii Volcanoes and Haleakala National Parks and elsewhere, and is a feasible solution for introduced mammal control in Hawaii. Eradication of introduced animals may sometimes be an option, given public support, and should also be considered.

1511. Determine fencing strategy.

A combination of methods will probably be the most effective strategy, using short-term, small-scale fencing to protect those populations under immediate threat from ungulates while longer-term, large-scale fencing projects are being undertaken. However, even "small" exclosures should be designed with a minimum area sufficient to offset the negative impacts of the actual fencing and fence and site maintenance (e.g. scarification of fenceline and adjacent area and potential introduction of new pests into the area). A minimum-sized exclosure should have its perimeter located at least 164 feet (50 meters) distant from the nearest individual of the target species. This should be viewed as a general guideline.

Fences should include, if possible, the target populations and a buffer area of good-quality, hopefully similar habitat, for potential replanting efforts (and/or native buffer habitat, if present, that are resistant to invasion of alien species). To reduce maintenance costs, fences should be constructed along ridgelines and tied into streamcourses at natural barriers (such as the tops of waterfalls) as much as possible.

Some specific areas and/or strategies for fencing are described in the species accounts for *Alsinidendron trinerve*, *Cyanea grimesiana* spp. *obatae*, *Cyanea pinnatifida*, and *Hedyotis parvula*.

1512. Construct and maintain fencing.

Once the best method for fencing the management areas is determined, fencing and maintenance plans should begin as soon as possible. Fences should be impervious to all ungulates found in the area(s).

Ongoing inspection and maintenance of fences is necessary to ensure the continued exclusion of ungulates from the fenced areas.

1513. Remove ungulates within fenced areas.

Once each fence is completed, all ungulates from within should be removed. It is important to realize the potentially detrimental impact management activities may have. Soil and vegetation disturbance by managers can create open areas for new alien species invasions, and direct damage can result from inappropriate or careless activities. Eradication options would include baited hunting, snaring, and poisoning. Also, hunting from helicopters is a highly effective method for introduced animal eradication, particularly for situations such as that in the Waianae area. Hunters and others who will be working in the habitat of the Waianae Recovery Plan taxa should be apprised of the existence of the plants so that they do not inadvertently damage them.

1514. Monitor fenced areas for ungulate damage and effects on weeds.

Ongoing monitoring for ungulates within the large fenced areas is necessary to ensure their continued absence. Monitoring should also include determining the effects of the exclusion of ungulates, since their hervbivory may have a more dramatic impact on invasive alien plants than on the endangered taxa. It is possible that without browsing by ungulates (until other management efforts can be devised and implemented) the present abundance of alien plants could quickly overwhelm some of the endangered taxa.

1515. Consider control of ungulates through eradication programs.

Ideally, island-wide programs to eradicate introduced ungulates should be instigated and supported, where applicable. The State of Hawaii's Wildlife Plan recommends the removal of feral goats from Oahu (DLNR 1984). Fences are maintenance-intensive, cannot be built in all areas due to topography, and are not altogether a foolproof method of protecting habitats necessary for the perpetuation of the Waianae Recovery Plan taxa. Ultimately, the eradication of introduced ungulate populations is the only way to completely eliminate these threats to the Waianae Recovery Plan taxa. Such removal of introduced animals will also slow down the degradation of watershed lands. However, public support of hunting is very fervent and the likelihood of acceptance of an ungulate eradication program seems remote. Pursuing the establishment of game preserves in Hawaii, where areas are set aside for hunting of game animals, should be a high priority within the State.

152. Conduct essential alien plant control.

One of the most important aspects of habitat management for the Waianae Recovery Plan taxa is the control of alien weeds. This may become even more important for some species if the removal of ungulates relieves grazing and browsing pressure on alien plants. It is important to realize the potentially detrimental impact management activities may have. Soil and vegetation disturbance by managers can create open areas for new alien species invasions, and direct damage can result from inappropriate or careless activities. Steps should always be taken to minimize these effects.

1521. Determine effective control methods.

For each negative effect known or discovered for any introduced species, effective control methods should be ascertained.

1522. Implement weed control.

Weed control should be aggressively implemented in the vicinity of the Waianae Recovery Plan taxa, particularly within and around fenced areas. Control methods may include, but are not limited to, hand-pulling and possibly local herbicide application in some cases. Weed control should begin immediately for each population beginning with the immediate vicinity of the existing plants and continuing until control is achieved in the full management site. Follow-up visits to each site are necessary to ensure that weeds are permanently controlled. Weed control must be ongoing and sites should be monitored periodically to determine when additional intervention is necessary.

Control efforts should be supervised by a botanist experienced in safe control methods to insure that crews do not compact soil, damage root systems or improperly apply herbicides. Also, care should be taken to protect associated native species, as well as the endangered species, during weed removal.

Some specific strategies for weed control are described in the species accounts for *Alsinidendron trinerve*, *Centaurium sebaeoides*, *Cyanea pinnatifida*, *Gouania vitifolia*, and *Stenogyne kanehoana*.

1523. Prevent introduction of new alien species to Hawaii.

Introduction of alien plants and other species to the State of Hawaii and between islands needs to be halted to prevent further threats to the Waianae Recovery Plan taxa and their habitats. To prevent the introduction of potentially detrimental alien species, support should be given to legislation, programs, or activities which limit the possibility of future introductions of alien species. The success of such programs or activities would contribute not only to the perpetuation of the endangered species in this plan, but to the quality of all native ecosystems as well as agricultural concerns in the State of Hawaii.

153. Provide necessary fire protection.

Protection from fire is critical to the survival of the Waianae Recovery Plan taxa. These plants are not well-adapted to survive fire, particularly those fires fed by unnatural buildup of fuel (such as that provided by the growth of alien grasses). In addition, many introduced plant species are better adapted to recovery after fires and often invade burned areas, permanently changing the habitat. Protection must be both local and on a larger scale to prevent fires from spreading to areas where the plants grow.

1531. Develop fire protection plans.

Plans to protect each site from fire should be developed. Makua Military Reservation and Honouliuli Preserve are the only areas that currently have a fire plan. Public education regarding the prevention and consequences of fires should be undertaken. "Fire-free" zones should be established, with hunters and other land users apprised of the dangers of smoking and open flames in sensitive areas (i.e. any dry areas). Firebreaks with a minimum width of 20 feet (6 meters) should be constructed around fire prone populations of the Waianae Recovery Plan plants wherever feasible. This minimum width is a guideline and may not be sufficient to protect populations from fire in especially dry conditions.

1532. Implement fire protection plans.

Implement the plans developed in task # 1531.

154. Control other introduced animals.

Threats not already addressed include predation by rodents, slugs, insects such as black twig borers, and possibly more host-specific pests. Monitoring and control of pests and disease should be implemented.

1541. Control rodents.

Control rodents as needed to allow reproduction of endangered plant taxa. Measures need to be taken as necessary to control rodent damage to the endangered plants and their fruits and seeds to allow reproduction of the plants. Intensive rodent control over a period prior to and during fruit production is recommended for at least one season or until a good production season occurs, in order to have a viable crop of seeds for collection and *ex situ* propagation.

1542. Control slugs, as needed.

Control slugs as needed to allow reproduction of endangered plant taxa. Measures need to be taken, as necessary, to control slug damage to the endangered plants and their fruits and seeds to allow reproduction of the plants.

1543. Control insects, as needed.

Control alien insects found detrimental, such as the black twig borer (*Xylosandrus compactus*) and two-spotted leafhopper (*Sophonia rufofascia*), to the applicable Waianae Recovery Plan taxa.

155. Control disease, if necessary.

If the results of Task #264 show that disease is a threat to any of the Waianae Recovery Plan taxa, then control measures should be implemented.

156. Ensure availability of pollination vectors.

Based on research findings in Task #21, measures should be established to ensure that pollination vectors remain available to the Waianae Recovery Plan taxa. If it is discovered that pollination vectors for certain taxa are in fact missing, necessary measures should be taken to compensate for these.

157. Protect areas from direct/indirect threats from humans.

Areas where the Waianae Recovery Plan taxa grow should be protected as much as possible from hikers, vehicles, and other possibilities of direct human disturbance. As a part of protection of areas from human use, public awareness and education regarding these endangered taxa should be fostered. Public education programs should be instigated, perhaps in conjunction with programs designed for other listed species. Other programs of public education regarding rare species and protection of native habitat should also be supported.

Signs designating sensitive environmental areas and/or research areas should be placed near sites where human contact may occur. "Kapu/No Trespassing" signs should prohibit entry to these areas. Such regulations should be strictly enforced by appropriate Federal and State agencies. If hiking is permitted, it is suggested that hikers must first be granted permission from the appropriate authority. This authority should be responsible for apprising hikers of the presence of sensitive environments and precautions which should be taken to avoid disturbance of such areas (e.g. cleaning of boots and clothing, the importance of staying on existing trails). Based on the specific situation, such signs may not be necessary for some populations that are in remote areas and/or areas not frequently visited. Signs may attract undue attention to these populations thereby exposing them to vandalism. Again, the decision regarding sign placement depends on the circumstances surrounding each population.

Where possible, roads and/or trails which pass through habitat of the Waianae Recovery Plan taxa should be rerouted or closed to prevent ready access to these areas. In cases where this is not feasible, care should be taken at any time during road or trail maintenance in or near habitat of the endangered taxa to avoid practices which would cause opening of canopies, excessive erosion, or other damage to the Waianae Recovery Plan plants or their habitat. All such activities should be closely monitored by an appropriate conservation agency.

158. Monitor status of wild populations.

Wild populations of all the Waianae Recovery Plan taxa should be monitored to ensure that current information is available regarding the status of each taxon. A detailed monitoring plan should be designed and implemented for each of the Waianae Recovery Plan taxa. Permanent plots around every occurrence of each taxon should be set up and mapped by size class in order to establish baseline information regarding population size and local distribution patterns as well as the occurrence of other species in the vicinity.

Individual plants may also be carefully tagged as appropriate for monitoring purposes. Data collection should include quantities and locations of all extant plants as well as any other relevant observations regarding habitat or situation. Plots should be set up to allow point- and/or line-intercept monitoring methods as appropriate for each situation.

Information such as changes in numbers of plants by size class, changes in vigor of individual plants, and changes or disturbances to the environment should be noted as appropriate and that data recorded.

159. Maintain genetic stock ex situ.

Cultivated populations of each Waianae Recovery Plan taxon should be maintained in order to establish pools of genetic resources for reintroduction to appropriate sites and to safeguard against loss of the material due to catastrophe in wild populations. It should be noted, however, that cultivation of these plants is not a substitute for their preservation in the wild. Additionally, the existence of cultivated plants may reduce any demand for field-collected specimens of these rare taxa by providing a propagated source of those taxa for which there might be a horticultural and/or research demand.

As broad a complement as possible of the existing genetic stock for each taxon should be preserved. For each identifiable population (either from extant sites or traceable, pure, cultivated material), genetic material from as many individuals as feasible should be collected. Collection methods and quantities of materials collected should be devised so as to have minimal impact on wild populations. All collected materials should be labelled accurately as to exact origin, collection date, etc.

Seeds of each taxon should be collected and entrusted to seed banks for long-term storage using the best available techniques for preservation. Seeds in long-term storage should be periodically tested for viability and recollected as necessary.

2. Conduct essential research.

Research into various aspects of the life history, habitat, pollinators, reproductive biology, symbionts, optimum requirements for growth, requirements for population viability, and control of threats to each of the Waianae Recovery Plan taxa must be carried out to better understand the requirements necessary for perpetuation of these plants. Such additional knowledge would allow more appropriate management and assessment techniques to be developed, and is needed in order to determine meaningful parameters for definition of specific recovery criteria for each taxon.

21. Collect diagnostic data on crucial associated ecosystem components.

Composition of flora and invertebrate, bird, and other fauna populations within each management area should be established to attempt to gain an understanding of any relationships between these organisms and the Waianae Recovery Plan plants. This will also assist managers in providing large areas of habitat in which these taxa may survive and reproduce without constant species-specific management.

22. Map alien vegetation.

Periodic mapping of alien vegetation is recommended using various techniques, including direct ground observations as well as aerial color and/or infrared photographs to compare with previous maps and photos and determine overall changes in alien vegetation patterns where the Waianae Recovery Plan plants occur. Advantages of aerial techniques include (1) the fact that such techniques are not directly invasive into the sensitive habitat of the endangered plants and that (2) large areas which may otherwise be inaccessible for observation may be monitored. Such mapping would allow changes in distributions and abundance of alien plants to be followed so that appropriate management actions may be taken.

23. Study various aspects of growth.

Various aspects of the growth of each taxon need to be studied, including: growth and mortality of seedlings; growth of mature plants, including seasonal changes, optimum conditions and limiting factors; seasonal differences in temperature and light needs; water sources and requirements; and soil and nutrient requirements.

24. Study reproductive viability.

Factors affecting the reproductive viability of each of the Waianae Recovery Plan taxa need to be determined, including: breeding systems, including self-compatibility; pollination vectors; and preferred conditions for flowering and seed set, reasons for lack of reproductive success and seedling establishment, and seed dispersal method/agent. This will allow the best management strategy for each taxon to be developed.

25. Determine parameters of viable populations.

Parameters of viable populations need to be established. Such information could be used to more precisely determine parameters for consideration of downlisting or delisting. These parameters include: minimum numbers of individuals and populations needed for long-term survival; demographics; longevity; minimum range needed for long-term survival; genetic relationships and susceptibility to inbreeding depression; and dispersal potential.

26. Determine genetic distinctiveness.

As specified in the species accounts, the genetic distinctiveness and taxonomic relationships need to be determined for the following species: *Diellia falcata*, *Diellia unisora*, *Hedyotis degeneri*, *Phyllostegia mollis*, *Tetramolopium filiforme*, *Viola chamissoniana* spp. *chamissoniana*.

27. Determine the kind and degree of threat posed by selected diseases/introduced species.

The effects of introduced species on the Waianae Recovery Plan taxa as well as the mechanisms of impact need to be determined in order to be able to better manage the endangered plants and their habitats.

271. Determine threat posed by rodents.

Determine the degree of threat as well as the mechanisms of impact on the Waianae Recovery Plan taxa posed by rodents.

272. Determine threat posed by slugs.

Determine the degree of threat as well as the mechanisms of impact on the Waianae Recovery Plan taxa posed by slugs.

273. Determine threat posed by insects.

Determine the degree of threat as well as the mechanisms of impact on the Waianae Recovery Plan taxa posed by alien insects found detrimental, such as the black twig borer (*Xylosandrus compactus*) and two-spotted leaf hopper (*Sophonia rufofascia*).

274. Determine threat of diseases or other introduced species.

If diseases or introduced species with negative impacts on the Waianae Recovery Plan taxa are discovered other than those listed, effects and mechanisms of each should be determined.

28. Determine effective control methods to combat selected diseases/introduced species.

Control methods to combat rodents, diseases and insects which adversely affect the Waianae Recovery Plan taxa need to be developed.

281. Determine control methods for rodents.

Research into effective methods of rodent control for all taxa where this is a threat needs to be undertaken, ensuring that control measures do not adversely affect components of the native ecosystem.

282. Determine control methods for slugs.

Research into effective methods of slug control for all taxa where this is a threat needs to be undertaken, ensuring that control measures do not adversely affect components of the native ecosystem.

283. Determine control methods for insects.

Research into effective methods of black twig borer and two-spotted leafhopper control for all taxa where there is a threat needs to be undertaken, ensuring that control measures do not adversely affect components of the native ecosystem.

284. Determine control methods for diseases and introduced pests.

If other diseases or introduced species with negative impacts on the Waianae Recovery Plan taxa are discovered, effective control methods for each should be determined.

29. Evaluate results and use in future management.

The results of the above studies should be evaluated and incorporated into the management process and development of scientifically credible recovery targets.

3. Expand existing wild populations.

It is hoped that by eliminating current threats through management, populations of the Waianae Recovery Plan taxa will expand naturally. However, in certain instances, wild populations of the Waianae Recovery Plan taxa may need to be augmented. This should be done conservatively and only after careful consideration of all factors involved, particularly the threat of introducing detrimental organisms into the wild populations. Augmentation efforts should always be well-documented as to lineage and methods.

31. Develop plans for expansion of each population, when necessary.

The need for expansion of current populations should be evaluated, and specific plans should be created for the augmentation of wild populations which need to be enhanced.

311. Identify sites for expansion.

Populations of each taxon should be evaluated and determination made as to whether they are appropriate for addition of living material. As new occurrences of each taxon are discovered, each new site should be evaluated for potential augmentation. Because their numbers are well below what is recommended for downlisting and/or delisting, populations of *Abutilon sandwicense*, *Alsinidendron obovatum*, *Alsinidendron trinerve*, *Centaurium sebaeoides*, *Chamaesyce celastroides* var. *kaenana*, *Cyanea grimesiana* ssp. *obatae*, *Cyanea pinnatifida*, *Cyanea superba*, *Diellia unisora*, *Dubautia herbstobatae*, *Gouania meyenii*, *Gouania vitifolia*, *Hedyotis degeneri*, *Hedyotis parvula*, *Hesperomannia arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lipochaeta tenuifolia*, *Lobelia niihauensis*, *Neraudia angulata*, *Nototrichium humile*, *Phyllostegia mollis*, *Sanicula mariversa*, *Schiedea kaalae*, *Silene perlmanii*, *Stenogyne kanehoana*, *Tetramolopium filiforme*, *Tetramolopium lepidotum* ssp. *lepidotum*, *Urera kaalae*, and *Viola chamissoniana* ssp. *chamissoniana* will almost certainly need to be considered for augmentation.

312. Identify material to be used for expansion.

For each selected population, material for expansion should be carefully chosen in order to best approximate the original material which exists or historically existed at the site to avoid genetic contamination of the population.

313. Determine optimum propagation methods.

Several methods are available which may be used to propagate these taxa. The most effective methods and techniques of propagating each taxon need to be determined. Any other propagation methods deemed suitable for these taxa should also be researched and used as necessary.

314. Determine appropriate augmentation methods.

Appropriate methods for augmentation of populations will need to be determined, taking into consideration principles for selection of sites and plant materials, site preparation, planting, and monitoring. Such decisions should be conservative and carefully considered.

32. Implement expansion plans.

After sites are protected, add *ex situ*-propagated material to existing wild populations in quantities and times deemed appropriate based on population and growth studies. Normally, progeny from plants of the same site/population should be used to augment a population in order not to contaminate the existing local gene pool with genetic material from other origins. Exceptions should be cleared with researchers knowledgeable about the species and its genetic makeup. The goal of such augmentation is to allow a better chance for populations to survive in areas where they are known to occur naturally. All phases of augmentation operations should be well documented.

321. Propagate *ex situ*.

Ex situ propagation should be pursued for all taxa to safeguard against loss of the material due to catastrophe in wild populations and for possible augmentation of current populations and reintroduction to appropriate sites. **Cultivation of these plants is not a substitute for their preservation in the wild.**

322. Prepare sites.

Each selected site must be prepared and protected appropriately, including the building of exclosures and exotic species control therein, as outlined in Tasks #13, #14, and #15.

323. Plant.

The selected material should then be planted. Care should be taken regarding the matching of soils if transplanting already-started plants due to differences in water retention around the root areas (i.e. if surrounding soil is more absorptive the soil directly around the roots could be overly dry and weaken or kill the newly-transplanted specimen).

324. Monitor and maintain new individuals.

Augmented populations should be monitored carefully. Ongoing maintenance of each site should occur after initial preparation and planting. The same protections and procedures regarding exclosures, ungulate removal, etc., should apply to new sites as have been recommended for existing sites. Any transplants which do not survive should be replaced.

4. Reestablish wild populations within the historic range.

If necessary to meet the downlisting and delisting objectives, populations should be reestablished in areas where they are known to have occurred, particularly if genetically uncontaminated, cultivated materials exist which are known to have originated from the historical site. The goal of reintroduction of these taxa is to permanently reestablish viable populations of these taxa within their former ranges in stable and secure conditions for their perpetuation.

41. Investigate feasibility and desirability of reintroduction.

For each taxon, appropriateness of reintroduction into wild situations should be assessed. Such reintroductions should be recommended conservatively and only after careful consideration of potential consequences. Genetic purity of populations is a prime concern, as are documentation of artificially established populations and the possibility of introducing pathogens to natural areas. Reintroduction efforts should always be well-documented as to lineage and methods.

42. Develop specific plans for reestablishment.

Specific plans should be created for the reestablishment of wild populations of each of the Waianae Recovery Plan taxa. Plans for each taxon should include documentation of all activities as well as the following general concepts.

421. Identify sites for reestablishment.

For taxa with very few extant sites, additional sites within the former range of the taxon should be identified for reintroduction of living material in order to meet the downlisting objectives. The choice of sites should be based on the best information available in order to match the site conditions to the requirements of the taxon.

4211. Identify reestablishment sites on Oahu.

Unless new populations are discovered, reestablishment sites on Oahu for *Alsinidendron obovatum*, *Alsinidendron trinerve*, *Centaurium sebaeoides*, *Chamaesyce kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyanea pinnatifida*, *Cyanea superba*, *Diellia unisora*, *Dubautia herbstobatae*, *Gouania meyenii*, *Gouania vitifolia*, *Hedyotis degeneri*, *Hedyotis parvula*, *Hesperomannia arbuscula*, *Lipochaeta lobata* var.

leptophylla, *Lipochaeta tenuifolia*, *Phyllostegia mollis*, *Sanicula mariversa*, *Schiedea kaalae*, *Silene perlmanii*, *Stenogyne kanehoana*, *Tetramolopium filiforme*, *Tetramolopium lepidotum* ssp. *lepidotum*, *Urera kaalae*, and *Viola chamissoniana* ssp. *chamissoniana* will have to be identified in order to reach downlisting and/or delisting objectives.

4212. Identify reestablishment sites on other islands.

Unless new populations are discovered, reestablishment sites on Oahu or other islands within the species' historical range for *Centaurium sebaeoides*, *Gouania meyenii*, *Gouania vitifolia*, *Hesperomannia arbuscula*, *Nototrichium humile*, *Phyllostegia mollis*, and *Tetramolopium lepidotum* ssp. *lepidotum* will have to be identified in order to reach downlisting and/or delisting objectives.

422. Identify material to be used for reestablishment.

For each selected site, material for reintroduction should be carefully chosen in order to best approximate the original material which did or might have existed in the site previously to avoid genetic contamination of any nearby populations.

43. Implement reestablishment plans.

Plans prepared for the reestablishment of populations should be implemented. Ensure that selected materials are free from pests, diseases, and pathogens which might be introduced to the new or nearby wild populations. This aspect is particularly critical since cultivated plants may have been grown in the presence of other pathogen-carrying plants, and nearby wild populations may have lower resistance to such introductions.

431. Protect reestablishment sites.

If the sites chosen in task # 421 are outside the management units already established in Task #12, they should be protected as discussed in Task #13.

432. Manage reestablishment sites.

Each selected site must be prepared and protected appropriately, including the building of exclosures and exotic species control therein, as necessary.

433. Plant.

The selected material should then be planted. Care should be taken regarding the matching of soils if transplanting already-started plants due to differences in water retention around the root areas (i.e. if surrounding soil in the transplant area is more absorptive than the soil used to start the plant, the roots could be overly dried and the newly-transplanted specimen could be weakened or could die).

434. Monitor and maintain new populations.

Newly established populations should be monitored carefully. Ongoing maintenance of each site should occur after initial preparation and planting. The same protections and procedures regarding exclosures, introduced animal removal, etc. as have been recommended for existing sites should apply to new sites.

5. Validate recovery objectives.

The scientific validity of the recovery objectives should be reviewed as more information becomes available.

51. Determine the number of individuals needed for long-term survival.

For each of the Waianae Recovery Plan taxa, a determination of the number of individuals needed in each population to ensure the long term maintenance of genetic diversity should be made.

52. Determine the number of populations needed for long-term survival.

For each of the Waianae Recovery Plan taxa, a determination of the number of populations needed for long term survival should be made.

53. Refine/revise downlisting and delisting criteria.

Based on scientific information gathered during recovery efforts (e.g. data on viable population sizes), recovery criteria for each of the Waianae Recovery Plan taxa should be revised to reflect the new information. Until such time as additional sound information is available, the criteria presented in this recovery plan should be used as the basis for downlisting and delisting.

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PART III. IMPLEMENTATION SCHEDULE

The Implementation Schedule that follows outlines actions and estimated cost for the Waianae Plant Cluster recovery program, as set forth in this recovery plan. It is a guide for meeting the objectives discussed in Part II of this Plan. This schedule indicates task priority, task numbers, task descriptions, duration of tasks, the agencies responsible for committing funds, and lastly, estimated costs. The agencies responsible for committing funds are not, necessarily, the entities that will actually carry out the tasks. When more than one agency is listed as the responsible party, an asterisk is used to identify the lead entity.

The actions identified in the implementation schedule, when accomplished, should protect habitat for the species, stabilize the existing populations and increase the population sizes and numbers. Monetary needs for all parties involved are identified to reach this point, whenever feasible.

Priorities in Column 1 of the following implementation schedule are assigned as follows:

Priority 1 -	An action that must be taken to prevent extinction or to prevent the species from declining irreversibly.
Priority 2 -	An action that must be taken to prevent a significant decline in species population/habitat quality, or some other significant negative impact short of extinction.
Priority 3 -	All other actions necessary to provide for full recovery of the species.

Key to Acronyms Used in Implementation Schedule

ADC - Animal Damage Control

CCH - City and County of Honolulu

C&C - Castle and Cooke

CE - Campbell Estate

CPC - Center for Plant Conservation

DLNR - Hawaii Department of Land and Natural Resources

DOD - Department of Defense

ES - U.S. Fish and Wildlife Service, Ecological Services, Honolulu, Hawaii

FWS-LE- U.S. Fish and Wildlife Service, Law Enforcement

HDOA - Hawaii Department of Agriculture

HHL - Hawaiian Home Lands

MLC - Mokuleia Land Co.

NBS - National Biological Survey

NTBG - National Tropical Botanical Garden, Lawai, Kauai

OTHER - Other Private Landowners

TBD - To Be Determined at a Later Date

TNC - The Nature Conservancy - Hawaii

USDA - U.S. Department of Agriculture

WAB - Wailuku Agribusiness

CPC - Center for Plant Conservation

O - Ongoing

C - Continuous

0 - Funding will Start at a Later Date

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Recovery Plan Implementation Schedule for the Waianae Plant Cluster

Priority Number	Task Number	Task Description	Task Duration (Years)	Responsible Party	Total Cost To 2015 $1000s	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	Comments
1	11	Identify and map all extant wild populations	5	DLNR*	250		50	50	50	50	
				ES	50		10	10	10	10	
				TNC	50		10	10	10	10	
1	112	Identify management units for preservation	3	ES*	15				5	5	
				DLNR	6				2	2	
				TNC	6				2	2	
1	131	Provide long-term security for Federal lands	Ongoing	DOD*	210	10	10	10	10	10	
				ES	105	5	5	5	5	5	
1	132	Provide long-term security for State of Hawaii lands	Ongoing	DLNR*	210	10	10	10	10	10	
				ES	105	5	5	5	5	5	
1	133	Provide long-term security for all other lands	Continuous	ES*	210	10	10	10	10	10	
				TNC	105	5	5	5	5	5	
				HHL	105	5	5	5	5	5	
				CE	105	5	5	5	5	5	
				CCH	105	5	5	5	5	5	
				C&C	105	5	5	5	5	5	
				WAB	105	5	5	5	5	5	
				MLC	105	5	5	5	5	5	
				Other	105	5	5	5	5	5	
1	14	Develop management plans for each unit	3	ES*	60				20	20	
				DOD	45				15	15	
				DLNR	45				15	15	
				TNC	45				15	15	
				HHL	30				10	10	
				CE	30				10	10	
				CCH	30				10	10	
				C&C	30				10	10	
				WAB	30				10	10	
				MLC	30				10	10	
				Other	30				10	10	

Recovery Plan Implementation Schedule for the Waianae Plant Cluster

Priority Number	Task Number	Task Description	Task Duration (Years)	Responsible Party	Total Cost To 2015 $1000s	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	Comments
1	1511	Determine fencing strategy	2	DLNR*	50				25	25	
				ES	10				5	5	
				DOD	10				5	5	
				TNC	6				3	3	
				HHL	4				2	2	
				CE	4				2	2	
				NBS	6				3	3	
				CCH	6				3	3	
				C&C	4				2	2	
				WAB	4				2	2	
				MLC	4				2	2	
				Other	4				2	2	
1	1512	Construct and maintain fencing	Continuous	DLNR*	1140					100	
				ES	1140					100	
				DOD	1140					100	
				TNC	135					10	
				HHL	71					5	
				CE	71					5	
				CCH	85					5	
				C&C	71					5	
				WAB	71					5	
				MLC	71					5	
				Other	71					5	
1	1513	Remove ungulates within fenced areas	10	DLNR*	500						
				ES	250						
				DOD	250						
				TNC	150						
				HHL	50						
				CE	50						
				CCH	150						
				C&C	50						
				WAB	50						
				MLC	50						
				Other	50						

Recovery Plan Implementation Schedule for the Waianae Plant Cluster

Priority Number	Task Number	Task Description	Task Duration (Years)	Responsible Party	Total Cost To 2015 $1000s	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	Comments
1	1514	Monitor fenced areas for ungulate damage and effects	Continuous	DLNR*	75						
				ES	15						
				DOD	15						
				TNC	15						
				HHL	15						
				CE	15						
				CCH	15						
				C&C	15						
				WAB	15						
				MLC	15						
				Other	15						
1	1531	Determine effective alien plant control methods	5	DLNR*	150		30	30	30	30	
				NBS	150		30	30	30	30	
1	1532	Implement alien plant control	Continuous	DLNR*	770			50	50	50	
				ES	435			30	30	30	
				DOD	435			30	30	30	
				TNC	290			20	20	20	
				HHL	77			5	5	5	
				CE	77			5	5	5	
				CCH	145			10	10	10	
				C&C	77			5	5	5	
				WAB	77			5	5	5	
				MLC	77			5	5	5	
				Other	77			5	5	5	

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Recovery Plan Implementation Schedule for the Waianae Plant Cluster

Priority Number	Task Number	Task Description	Task Duration (Years)	Responsible Party	Total Cost To 2015 $1000s	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	Comments
2	4211	Identify reestablishment sites on Oahu	5	DLNR* ES	75 50			15 10	15 10	15 10	

Recovery Plan Implementation Schedule for the Waianae Plant Cluster

Priority Number	Task Number	Task Description	Task Duration (Years)	Responsible Party	Total Cost To 2015 $1000s	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	Comments
1	1541	Develop fire protection plans	5	DLNR* ES DOD TNC CCH	50 50 50 25 25		10 10 10 5 5	10 10 10 5 5	10 10 10 5 5	10 10 10 5 5	
1	1542	Implement fire protection plans	Continuous	DLNR* ES DOD TNC CCH	240 240 240 240 240			20 20 20 20 20	20 20 20 20 20	20 20 20 20 20	
1	1551	Control rodents	Continuous	DLNR* ES	190 190			10 10	10 10	10 10	
1	1552	Control slugs, as needed	TBD	DLNR* ES	0 0		TBD				
1	156	Control disease, if necessary	TBD	DLNR* ES	0 0		TBD				
1	157	Ensure availability of natural polination vectors	TBD	DLNR* ES	0 0		TBD				

Recovery Plan Implementation Schedule for the Waianae Plant Cluster

Priority Number	Task Number	Task Description	Task Duration (Years)	Responsible Party	Total Cost To 2015 $1000s	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	Comments
NEED 4 (Reestablish in Former Range)					525	0	0	105	105	105	
3	51	Determine number of individuals for long-term survival	3	NBS* ES	60 60						

Recovery Plan Implementation Schedule for the Waianae Plant Cluster											
Priority Number	Task Number	Task Description	Task Duration (Years)	Responsible Party	Total Cost To 2015 $1000s	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	Comments
1	158	Protect management areas from human threats	Continuous	DLNR* ES TNC DOD CCH HHL CE C&C WAB MLC Other	600 600 200 600 200 100 100 100 100 100 100		30 30 10 30 10 5 5 5 5 5 5	30 30 10 30 10 5 5 5 5 5 5	30 30 10 30 10 5 5 5 5 5 5	30 30 10 30 10 5 5 5 5 5 5	
1	159	Monitor status of wild populations	Continuous	DLNR* ES TNC DOD	200 60 60 60		10 3 3 3	10 3 3 3	10 3 3 3	10 3 3 3	
1	1510	Maintain genetic stock	Ongoing	DLNR* ES NTBG CPC	120 120 270 120	10 10 30 10	10 10 30 10	10 10 30 10	5 5 10 5	5 5 10 5	
2	152	Consider ungulate eradication programs	3	DLNR* ES	15 9		5 3	5 3	5 3		
2	1533	Prevent introduction of new alien plant species	Ongoing	DLNR* USDA HDOA	42 42 42	2 2 2	2 2 2	2 2 2	2 2 2	2 2 2	

Recovery Plan Implementation Schedule for the Waianae Plant Cluster

Priority Number	Task Number	Task Description	Task Duration (Years)	Responsible Party	Total Cost To 2015 $1000s	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	Comments
2	1553	Control black twig borer as needed	TBD	DLNR* ES	0 0		TBD				
NEED 1 (Protect and Manage Current Populations)					17042	146	483	773	938	1275	
2	21	Collect data on ecosystem components	10	NBS* DLNR ES	300 100 100		30 10 10	30 10 10	30 10 10	30 10 10	
2	22	Map alien vegetation	Continuous	DLNR* ES TNC NBS	120 56 56 56		15 10 10 10	15 10 10 10	5 2 2 2	5 2 2 2	
2	23	Study various aspects of growth	10	NBS* ES DLNR	200 200 200		20 20 20	20 20 20	20 20 20	20 20 20	
2	24	Study reproductive viability	10	NBS* ES DLNR	200 200 200		20 20 20	20 20 20	20 20 20	20 20 20	
2	25	Determine parameters of viable populations	10	NBS* ES DLNR	200 200 200		20 20 20	20 20 20	20 20 20	20 20 20	

Recovery Plan Implementation Schedule for the Waianae Plant Cluster

Priority Number	Task Number	Task Description	Task Duration (Years)	Responsible Party	Total Cost To 2015 $1000s	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	Comments
2	26	Determine genetic distinctiveness	10	NBS*	100		10	10	10	10	
				ES	100		10	10	10	10	
				DLNR	100		10	10	10	10	
2	271	Determine threat posed by rodents	5	DLNR*	35		7	7	7	7	
				ES	35		7	7	7	7	
				NBS	35		7	7	7	7	
2	272	Determine threat posed by slugs	5	DLNR*	25		5	5	5	5	
				ES	25		5	5	5	5	
				HDOA	25		5	5	5	5	
				NBS	25		5	5	5	5	
2	273	Determine threat posed by black twig borer	5	DLNR*	25		5	5	5	5	
				ES	25		5	5	5	5	
				HDOA	25		5	5	5	5	
				NBS	25		5	5	5	5	
2	274	Determine threats of other diseases or pests	5	DLNR*	25		5	5	5	5	
				ES	25		5	5	5	5	
				HDOA	25		5	5	5	5	
				NBS	25		5	5	5	5	
2	281	Determine effective controls for rodents	5	DLNR*	150		30	30	30	30	
				NBS	150		30	30	30	30	
				ES	50		10	10	10	10	
				USDA	50		10	10	10	10	
				ADC	50		10	10	10	10	

Recovery Plan Implementation Schedule for the Waianae Plant Cluster

Priority Number	Task Number	Task Description	Task Duration (Years)	Responsible Party	Total Cost To 2015 $1000s	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	Comments
2	282	Determine effective controls for slugs	5	DLNR ES HDOA NBS*	0 0 0 0			TBD TBD TBD TBD			
2	283	Determine effective controls for black twig borer	5	DLNR ES HDOA NBS*	0 0 0 0			TBD TBD TBD TBD			
2	284	Determine effective controls for other diseases/pests	5	DLNR ES HDOA NBS*	0 0 0 0			TBD TBD TBD TBD			
2	29	Evaluate results for use in future management	Continuous	DLNR ES NBS* TNC	190 190 190 190			10 10 10 10	10 10 10 10	10 10 10 10	
NEED 2 (Conduct Essential Research)					4503	0	476	516	482	482	
2	311	Identify sites for expansion	5	DLNR* ES NBS	75 50 75			15 10 15	15 10 15	15 10 15	
2	312	Identify material for expansion	5	DLNR* ES NBS CPC	50 35 50 35			10 7 10 7	10 7 10 7	10 7 10 7	

Recovery Plan Implementation Schedule for the Waianae Plant Cluster

Priority Number	Task Number	Task Description	Task Duration (Years)	Responsible Party	Total Cost To 2015 $1000s	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	Comments
2	313	Determine optimum propagation methods	10	DLNR* NTBG ES	80 80 40			10 10 5	10 10 5	10 10 5	
2	314	Determine appropriate augmentation techniques	5	DLNR* NTBG ES	375 375 250			75 75 50	75 75 50	75 75 50	
2	321	Propagate ex situ	Ongoing	DLNR* NTBG ES	1050 1050 525	50 50 25	50 50 25	50 50 25	50 50 25	50 50 25	
2	322	Prepare sites	5	DLNR* TNC ES	0 0 0				TBD TBD TBD		
2	323	Plant	10	DLNR* TNC ES	0 0 0					TBD TBD TBD	
2	324	Monitor and maintain new individuals	Continuous	DLNR* TNC DOD ES	0 0 0 0						
NEED 3 (Expand Current Populations)					4195	125	125	424	424	424	
2	41	Investigate feasibility and desirability of reintroduction	5	DLNR* ES NBS	50 25 25			10 5 5	10 5 5	10 5 5	

Recovery Plan Implementation Schedule for the Waianae Plant Cluster

Priority Number	Task Number	Task Description	Task Duration (Years)	Responsible Party	Total Cost To 2015 $1000s	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	Comments
2	4211	Identify reestablishment sites on Oahu	5	DLNR* ES NBS	75 50 75			15 10 15	15 10 15	15 10 15	
2	4212	Identify reestablishment sites on other islands	5	DLNR* ES NBS	50 25 50			10 5 10	10 5 10	10 5 10	
2	422	Identify material for reestablishment	5	DLNR* ES NBS CPC	25 25 25 25			5 5 5 5	5 5 5 5	5 5 5 5	
2	431	Protect reestablishment sites	3	ES* DLNR TNC	0 0 0			TBD TBD TBD			
2	432	Prepare reestablishment sites	5	DLNR* ES TNC	0 0 0				TBD TBD TBD		
2	433	Plant	10	DLNR* ES TNC	0 0 0						
2	434	Monitor and maintain new populations	Continuous	DLNR* ES TNC	0 0 0						

Recovery Plan Implementation Schedule for the Waianae Plant Cluster

Priority Number	Task Number	Task Description	Task Duration (Years)	Responsible Party	Total Cost To 2015 $1000s	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	Comments
NEED 4 (Reestablish in Former Range)					525	0	0	105	105	105	
3	51	Determine number of individuals for long-term survival	3	NBS* ES DLNR	60 60 60						
3	52	Determine number of populations for long-term survival	3	NBS* ES DLNR	60 60 60						
3	53	Refine/revise downlisting criteria	3	ES* DLNR	60 60						
NEED 5 (Validate Recovery Objectives)					480	0	0	0	0	0	
TOTAL COST					26745	271	1084	1818	1949	2286	

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Volcano, HI 96718

Dr. Diane Ragone (**)
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Ms. Kate Reinard
Director, Community Support
Kokee Natural History Museum
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Kekaha, HI 96752

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Fish and Wildlife Service
Pacific Islands Office
P.O. Box 50167
Honolulu, HI 96850

Mr. Fred C. Schmidt
Head, Documents Dept.
The Libraries
Colorado State University
Ft. Collins, CO 80523

Mr. Peter Schuyler
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Department of Land and Natural Resources
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Mr. Kevin Shaney, President - Land Company
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Honolulu, HI 96803

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Department of Range Science
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Fort Collins, CO 80523

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San Francisco, CA 94104-4230

Dr. Karen Shigematsu/Ranjit Coorey (**)
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Mr. Zane Smith
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San Francisco, California 94111

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University of Hawaii
Dept. of General Science
2450 Campus Rd., Dean Hall 2
Honolulu, HI 96822

University of Hawaii (*)
Environmental Center
2550 Campus Rd., Crawford Hall 317
Honolulu, HI 96822

Environmental Protection Specialist (*)
Directorate of Public Works
U.S. Army
Attn - APVG - GWV
Schofield Barracks, HI 96857

U.S. Army Corps of Engineers
Environmental Branch
CEPOD-ED-ME, Building T223
Fort Shafter, HI 96858

U.S. Army Engineering District - Honolulu
Attn: CEPOD-ED-PV
Bldg. 230
Ft. Shafter, HI 96858-5440

U.S. Forest Service
Institute of Pac. Islands Forestry
1151 Punchbowl St., Rm. 323
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Smithsonian Institution
Washington D.C. 20560

Waianae Mountains Feral Goat Mgmt. Team
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Mr. Mike Wilson
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Mr. Keith R. Woolliams
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Joan Yoshioka
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Honolulu, HI 96817

Ms. Marjorie F.Y. Ziegler
Sierra Club Legal Defense Fund, Inc.
212 Merchant Street, Suite 202
Honolulu, Hawaii 96813

(*) - Comments were received
(**) - Personal communication received

APPENDIX B SUMMARY OF ASSOCIATED SPECIES

COASTAL DRY SHRUBLAND

Elevation: 0-300 meters (0-990 feet)
Rainfall: <120 centimeters/year (47 inches)

Waianae Recovery Plan Species

Centaurium sebaeoides
Chamaesyce celastroides var. *kaenana*

Associated Listed Species

Sesbania tomentosa - Endangered[*]

Associated Candidate Species

Schiedea kealiae - C1

Associated Species of Concern

Capparis sandwichiana

Associated Native Species

Canthium odoratum
Eragrostis variabilis
Gossypium tomentosum (ma'o)
Jacquemontia ovalifolia spp. *sandwicensis* (pa'uohi'iaka)
Bidens (ko'oko'olau)
Lipochaeta (nehe)
Myoporum sandwicense
Santalum freycinetianum (sandalwood)
Sida fallax ('ilima)

Associated Alien Species

Acacia farnesiana
Cenchrus ciliarus
Leucaena leucocephala (koa haole)
Panicum maximum
Prosopis pallida

DRY - MESIC VEGETATION

Elevation: 5-760 meters (17-2,508 feet)
Rainfall: 100-200 centimeters/year (39-78 inches)

Waianae Recovery Plan Species

Abutilon sandwicense
Chamaesyce kuwaleana
Dubautia herbstobatae
Gouania vitifolia
Lipochaeta lobata var. *leptophylla*
Lobelia niihauensis
Nototrichium humile
Tetramolopium filiforme
Tetramolopium lepidotum spp. *lepidotum*

ISLAND OF OAHU

Associated Listed Species

Bonamia menziesii - Endangered[4]
Caesalpinia kavaiensis - Endangered[2]
Silene lanceolata - Endangered[3]
Spermolepis hawaiiensis - Endangered[4]

Associated Candidate Species

Euphorbia haeleeleana - C1
Korthalsella degeneri - C1
Labordia cyrtandrae - C1
Schiedea hookeri - C1

Associated Species of Concern

Bobea timonioides
Capparis sandwichiana

Associated Native Species

Acacia koa (koa)
Artemisia sp. ('ahinahina)
Canthium odoratum (alahe'e)
Diospyros sandwincense
Dodonaea viscosa ('a'ali'i)
Eragrostis variabilis (kawelu)
Erythrina sandwicensis
Sida fallax ('ilima)
Bidens sp. (ko'oko'olau)
Lipochaeta sp. (nehe)
Metrosideros polymorpha ('ohi'a)
Plectranthus parviflorus ('ala'ala wai nui)
Schiedea mannii

Associated Alien Species

Leucaena leucocephala (koa haole)
Erigeron karvinskianus (daisy fleabane)
Adenophorus riparia (Hamakua pamakani)
Melinus minutiflora (molasses grass)
Passiflora suberosa (huehue haole)
Psidium cattleianum (strawberry guava)
Schinus terebinthifolius (Christmasberry)

MESIC FOREST

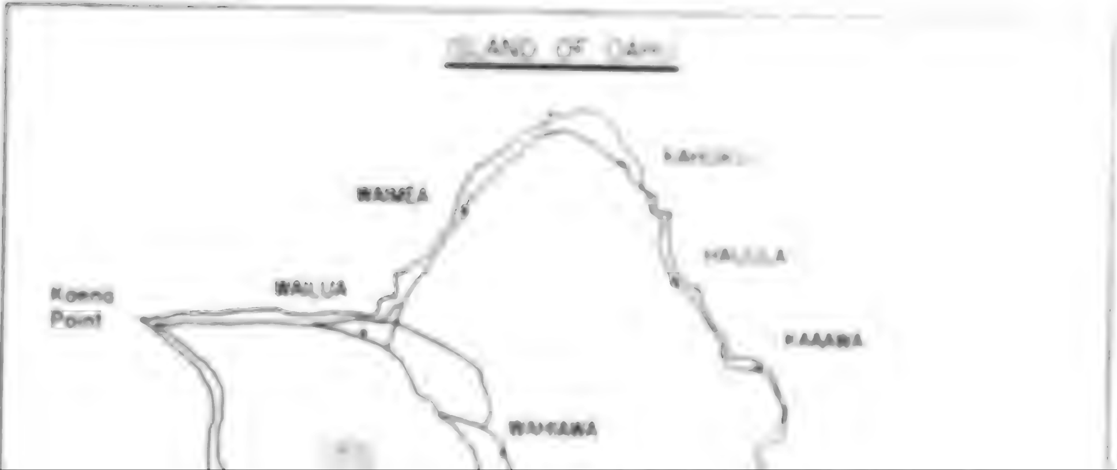
Elevation: 700-750 meters (2,310-2,475 feet)
Rainfall: 120-250 centimeters/year (564-1176 inches)

Waianae Recovery Plan Species

Gouania vitifolia
Stenogyne kanehoana

Associated Listed Species

Alectryon macrococcus var. *macrococcus* - Endangered[1]
Ctenitis squamigera - Endangered[3]
Flueggea neowawraea - Endangered[4]
Solanum sandwicense - Endangered[4]



ISLAND OF OAHU

Associated Candidate Species

Cyanea grimesiana spp. *grimesiana* - C1
Eragrostis fosbergii - C1
Isodendrion laurifolium - C1
Isodendrion longifolium - C1
Platydesma cornuta var. *decurrens* - C1
Schiedea nuttallii - C1

Associated Species of Concern

Dubautia sherffiana
Exocarpos gaudichaudii

Associated Native Species

Acacia koa (koa)
Dicranopteris linearis (uluhe)
Freycinetia arborea ('ie'ie)
Metrosideros polymorpha (o'hi'a)

Associated Alien Species

Lantana camara (lantana)
Clidemia hirta (Kostner's curse)
Melinus minutiflora (molasses grass)
Passiflora suberosa (huehue haole)
Psidium cattleianum (strawberry guava)
Schinus terebinthifolius (Christmasberry)

DIVERSE MESIC FOREST

Elevation: 30-1,600 meters (99-5,280 feet)
Rainfall: 120-380 centimeters/year (47-149 inches)

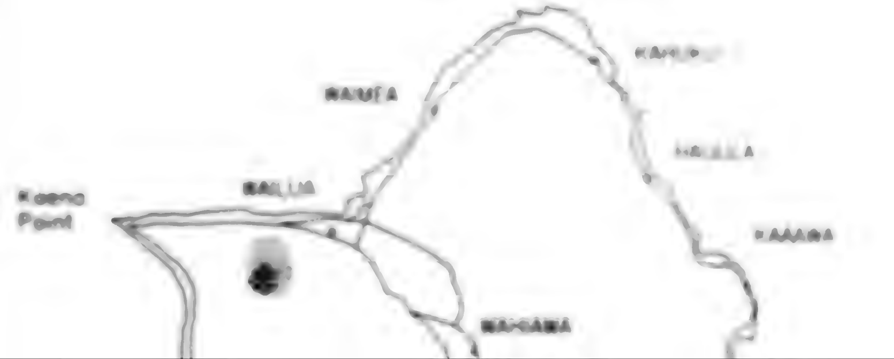
Waianae Recovery Plan Species

Alsinidendron obovatum
Cyanea grimesiana ssp. *obatae*
Cyanea pinnatifida
Cyanea superba
Diellia falcata
Diellia unisora
Gouania meyenii
Hedyotis degeneri
Hedyotis parvula
Hesperomannia arbuscula
Lipochaeta tenuifolia
Neraudia angulata
Phyllostegia mollis
Sanicula mariversa
Schiedea kaalae
Silene perlmanii
Urera kaalae
Viola chamissoniana spp. *chamissoniana*

Associated Listed Species

Caesalpinia kavaiensis (uhiuhi) - Endangered[2]
Peucedanum sandwicense - Threatened[4]
Plantago princeps var. *princeps* - Endangered[4]

ISLAND OF OAHU



Associated Candidate Species

Cenchrus agrimonioides var. *agrimonioides* - C1
Cyanea membranacea (haha) - C1
Delissea subcordata - C1
Lepidium arbuscula - C1
Phyllostegia parviflora - C1

Associated Native Species

Dodonaea viscosa (‘a‘ali‘i)
Acacia koa (koa)
Artemisia sp. (‘ahinahina)
Alyxia oliviformis (maile)
Athyrium sandwicensis
Bidens sp. (ko‘oko‘olau)
Claoxylon sandwicense (po‘ola)
Diospyros (lama)
ferns
Hedyotis terminalis (manono)
Ilex anomala (kawa‘u)
Lysimachia hillebrandii (kolokolo kuahiwi)
Pipturus albidus (mamaki)
Melicope sandwicensis (alani)
Metrosideros polymorpha (‘ohi‘a)
Nestegis sandwicensis (olopua)
Pisonia umbellifera (papala kepau)
Pouteria sandwicensis (‘ala‘a)
Psychotria sp. (kopiko)
Sapindus oahuensis (aulu)
Senna guadichaudii (kolomona)

Associated Alien Species

Ageratina riparia (Hamakua pamakani)
Aleurites moluccana (kukui)
Blechnum occidentale
Clidemia hirta (Koster's curse)
Erigeron karvinskianus (daisy fleabane)
Passiflora suberosa (huehue haole)
Leucaena leucocephala (Koa haole)
Melinus minutiflora (molasses grass)
Myrica faya (firetree)
Passiflora suberosa (huehue haole)
Psidium cattleianum (strawberry guava)
Psidium guajava (guava)
Rubis (raspberry)
Rubus argutus (blackberry)
Schinus terebinthifolius (Christmasberry)
Syzygium cumini (java plum)

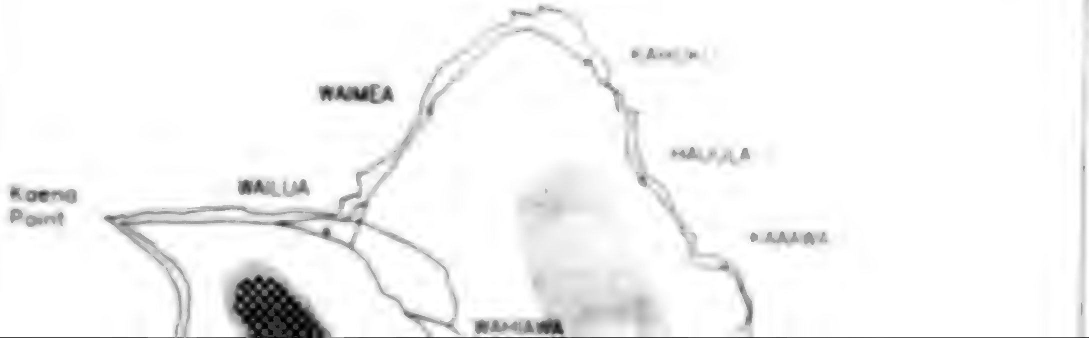
WET FOREST

Elevation: 550-670 meters (1,815-2,211 feet)
Rainfall: >250 centimeters/year (98 inches)

Waianae Recovery Plan Species

Alsinidendron trinerve

ISLAND OF OAHU



Associated Listed Species

Diplazium molokaiense - Endangered[5]

Associated Candidate Species

Joinvillea ascendens - C1
Labordia cyrtandrae - C1
Melicope christophersenii - C1

Associated Native Species

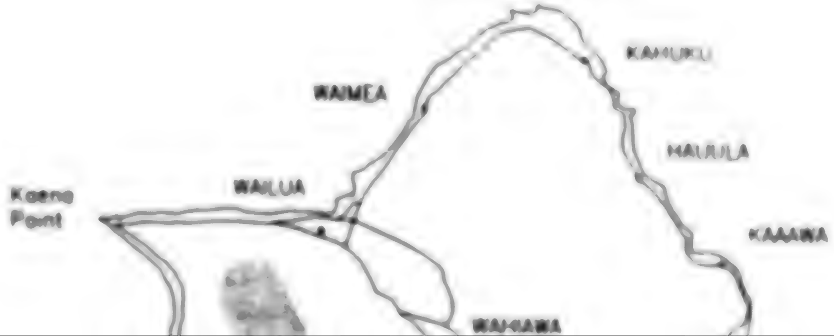
Cheirodendron platyphyllum
Coprosma ochracea (pilo)
Dicranopteris linearis
Dubatia laxa
Gunnera sp. ('ape'ape)
Machaerina angustifolia
Metrosideros polymorpha

Associated Alien Species

Rubis argutus (blackberry)

C1 = Taxa is a candidate for immediate listing.
1 = Recovery will be addressed in the Big Island (Hawaii) Cluster Recovery Plan.
2 = Recovery will be addressed in the *Kokia drynarioides* and *Caesalpina kavaiensis* Recovery Plan.
3 = Recovery will be addressed in the Molokai Cluster Recovery Plan.
4 = Recovery will be addressed in the Kauai Cluster Recovery Plan.
5 = Recovery will be addressed in the Fern Recovery Plan.
6 = Recovery will be addressed in the Multi-Island Cluster Recovery Plan.

ISLAND OF OAHU



APPENDIX C SUMMARY OF LANDOWNERSHIP/MANAGEMENT

Department of Defense (Army)

Alsinidendron trinerve; *Chamaesyce celastroides* var. *kaenana*; *Cyanea superba*; *Diellia falcata*; *Dubautia herbstobatae*; *Hedyotis parvula*; *Lipochaeta lobata* var. *leptophylla*; *Lipochaeta tenuifolia*; *Lobelia niihauensis*; *Neraudia angulata*; *Nototrichium humile*; *Phyllostegia mollis*; *Sanicula mariversa*; *Tetramolopium filiforme*; *Tetramolopium lepidotum* spp. *lepidotum*; *Viola chamissoniana* spp. *chamissoniana*

Department of Defense (Navy)

Abutilon sandwicense; *Chamaesyce kuwaleana*; *Cyanea grimesiana* ssp. *obatae*; *Diellia falcata*; *Diellia unisora*; *Hedyotis parvula*; *Lipochaeta lobata* var. *leptophylla*; *Lobelia niihauensis*; *Neraudia angulata*; *Nototrichium humile*; *Silene perlmanii*; *Tetramolopium lipidotum* spp. *lepidotum*; *Urera kaalae*; *Viola chamissoniana* spp. *chamissoniana*

State of Hawaii

Abutilon sandwicense; *Alsinidendron obovatum*; *Centaurium sebaeoides*; *Chamaesyce celastroides* var. *kaenana*; *Chamaesyce kuwaleana*; *Cyanea superba*; *Diellia falcata*; *Dubautia herbstobatae*; *Gouania meyenii*; *Gouania vitifolia*; *Hedyotis degeneri*; *Hedyotis parvula*; *Hesperomannia arbuscula*; *Lipochaeta tenuifolia*; *Lobelia niihauensis*; *Neraudia angulata*; *Nototrichium humile*; *Sanicula mariversa*; *Schiedea kaalae*; *Tetramolopium filiforme*; *Urera kaalae*

The Nature Conservancy of Hawaii

Abutilon sandwicense; *Cyanea grimesiana* ssp. *obatae*; *Cyanea pinnatifida*; *Diellia falcata*; *Diellia unisora*; *Hesperomannia arbuscula*; *Neraudia angulata*; *Nototrichium humile*; *Phyllostegia mollis*; *Schiedea kaalae*; *Silene perlmanii*; *Stenogyne kanehoana*; *Tetramolopium lepidotum* spp. *lepidotum*; *Urera kaalae*

City and County of Honolulu

Diellia falcata; *Dubautia herbstobatae*; *Gouania meyenii*; *Hesperomannia arbuscula*; *Lipochaeta tenuifolia*; *Lobelia niihauensis*; *Neraudia angulata*; *Nototrichium humile*; *Sanicula mariversa*; *Viola chamissoniana* spp. *chamissoniana*

Hawaiian Home Lands

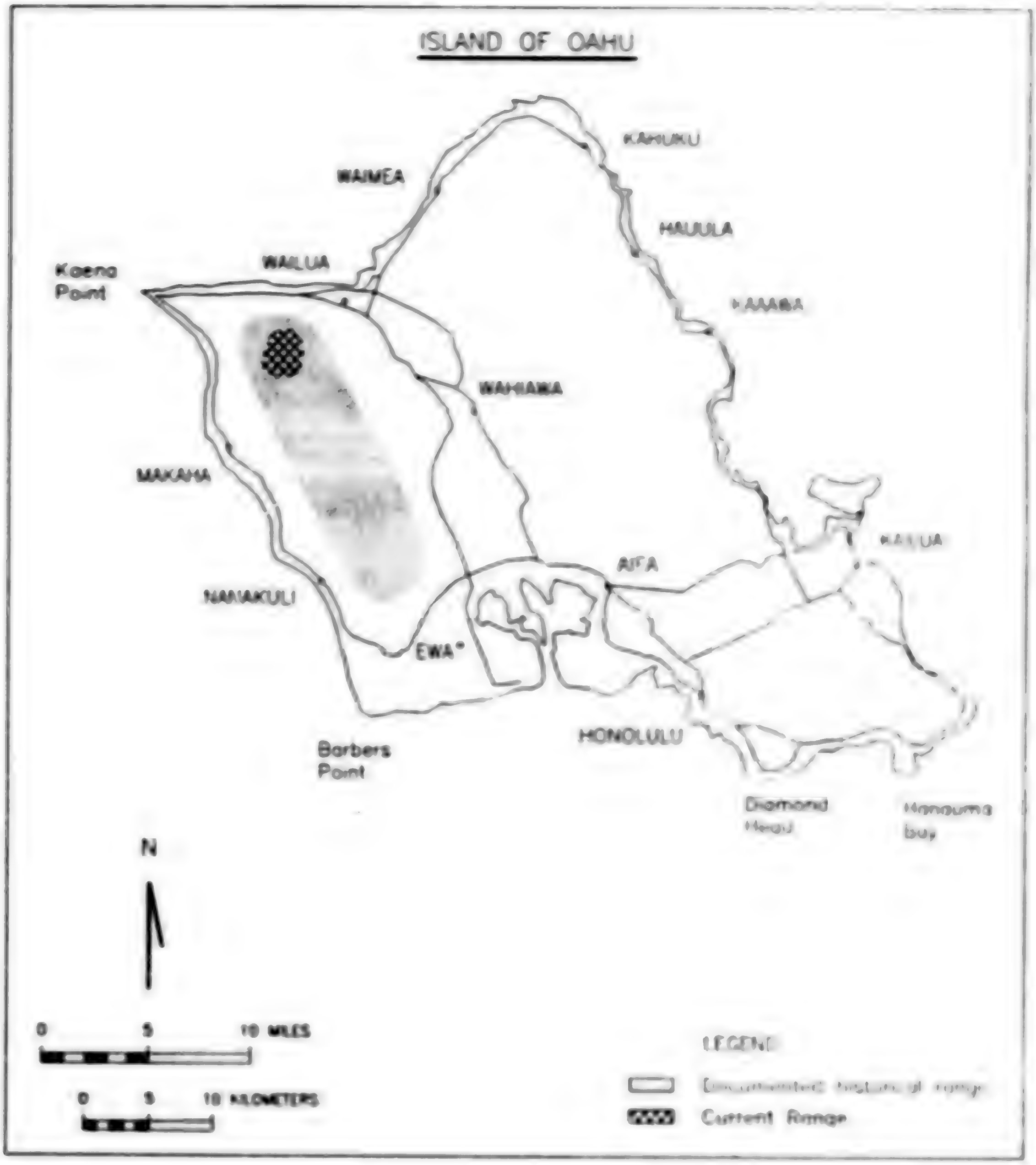
Abutilon sandwicense; *Centaurium sebaeoides*; *Diellia falcata*; *Diellia unisora*; *Hedyotis parvula*; *Lobelia niihauensis*; *Nototrichium humile*; *Silene perlmanii*; *Tetramolopium lepidotum* spp. *lepidotum*; *Urera kaalae*

Private Landowners

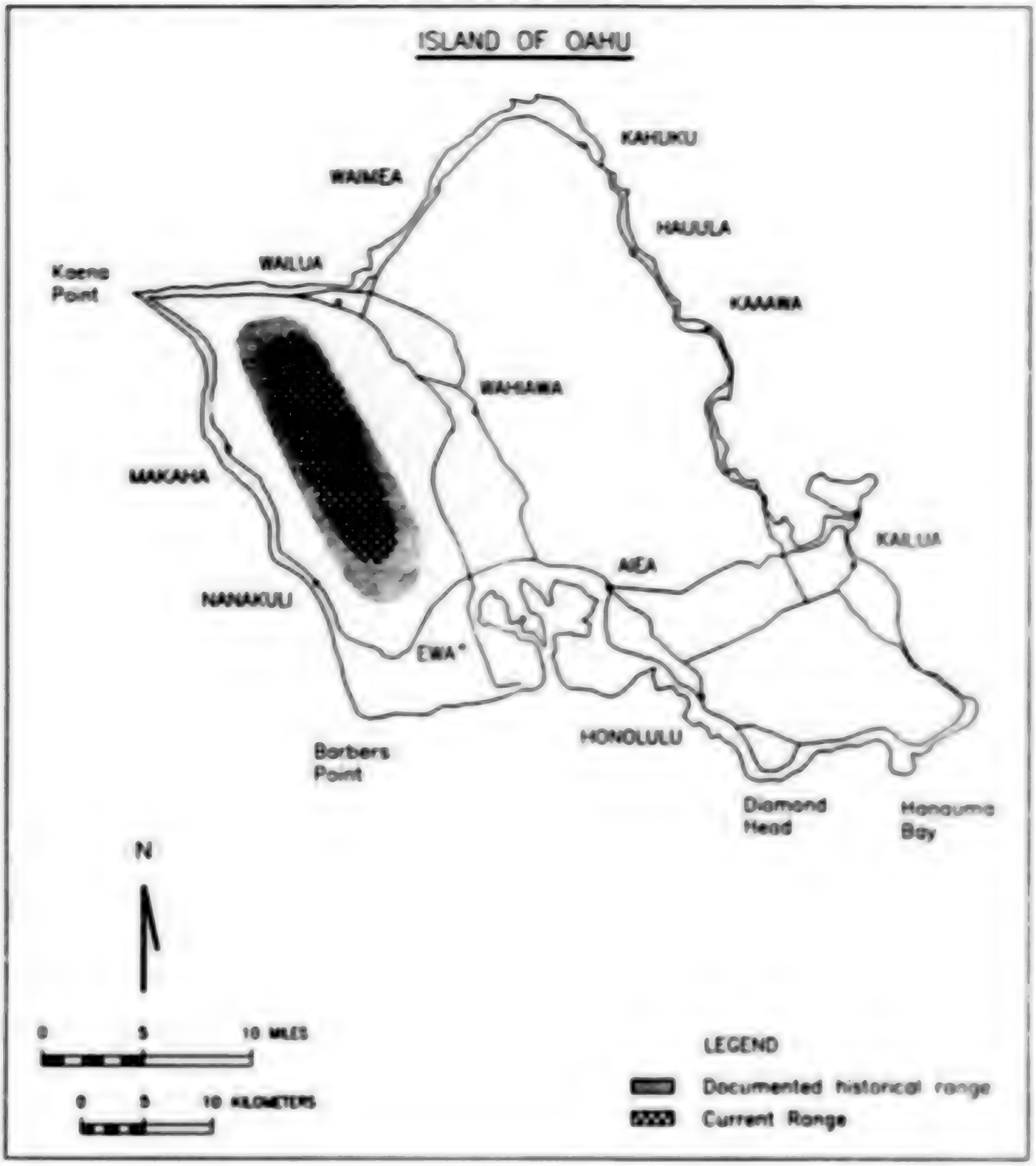
Centaurium sebaeoides; *Lobelia niihauensis*; *Nototrichium humile*

ISLAND OF OAHU

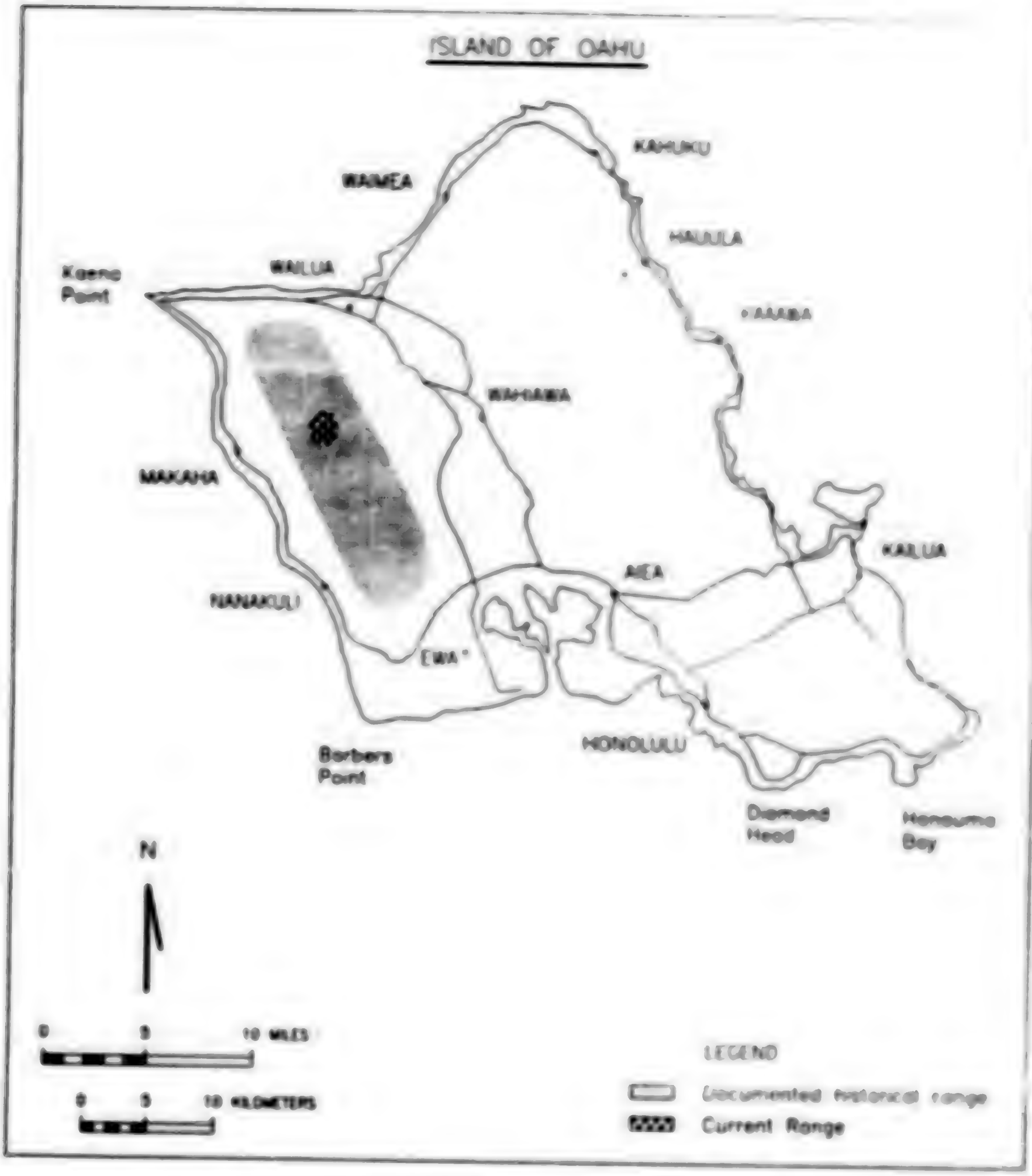
APPENDIX D HISTORIC AND CURRENT RANGES



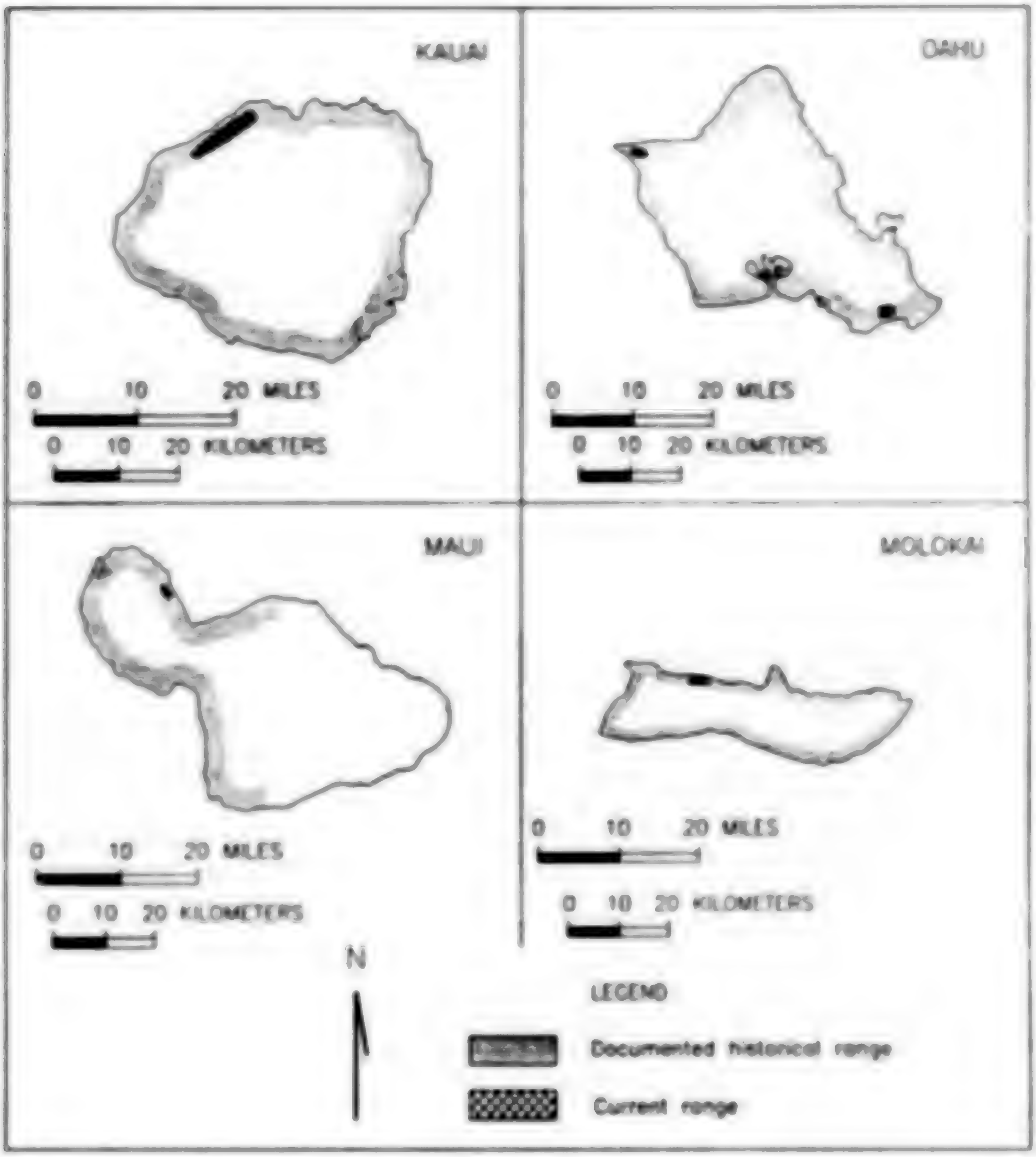
Historic and current range for *Alsinidendron obovatum*



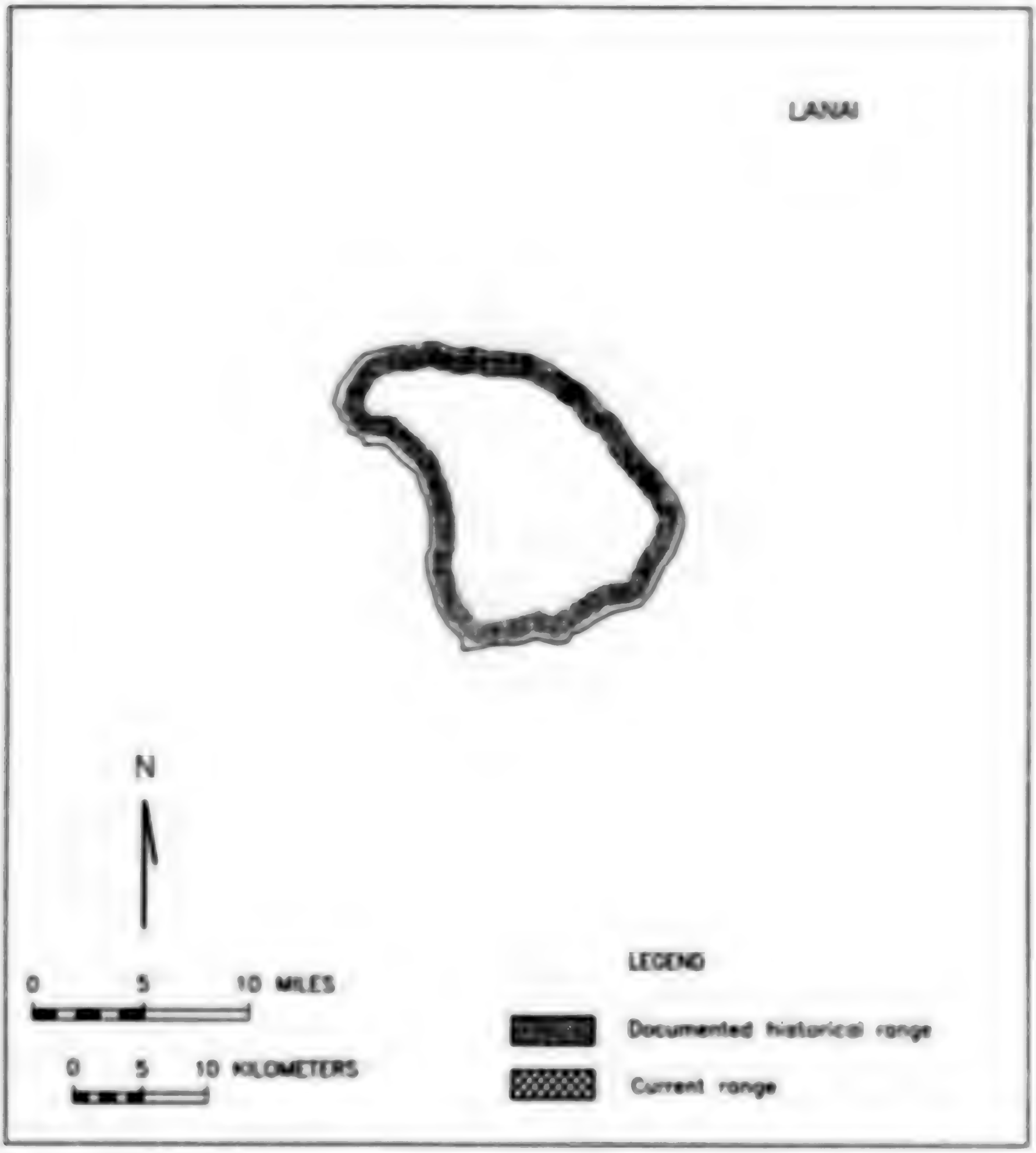
Historic and current range for Abutilon sandwicense



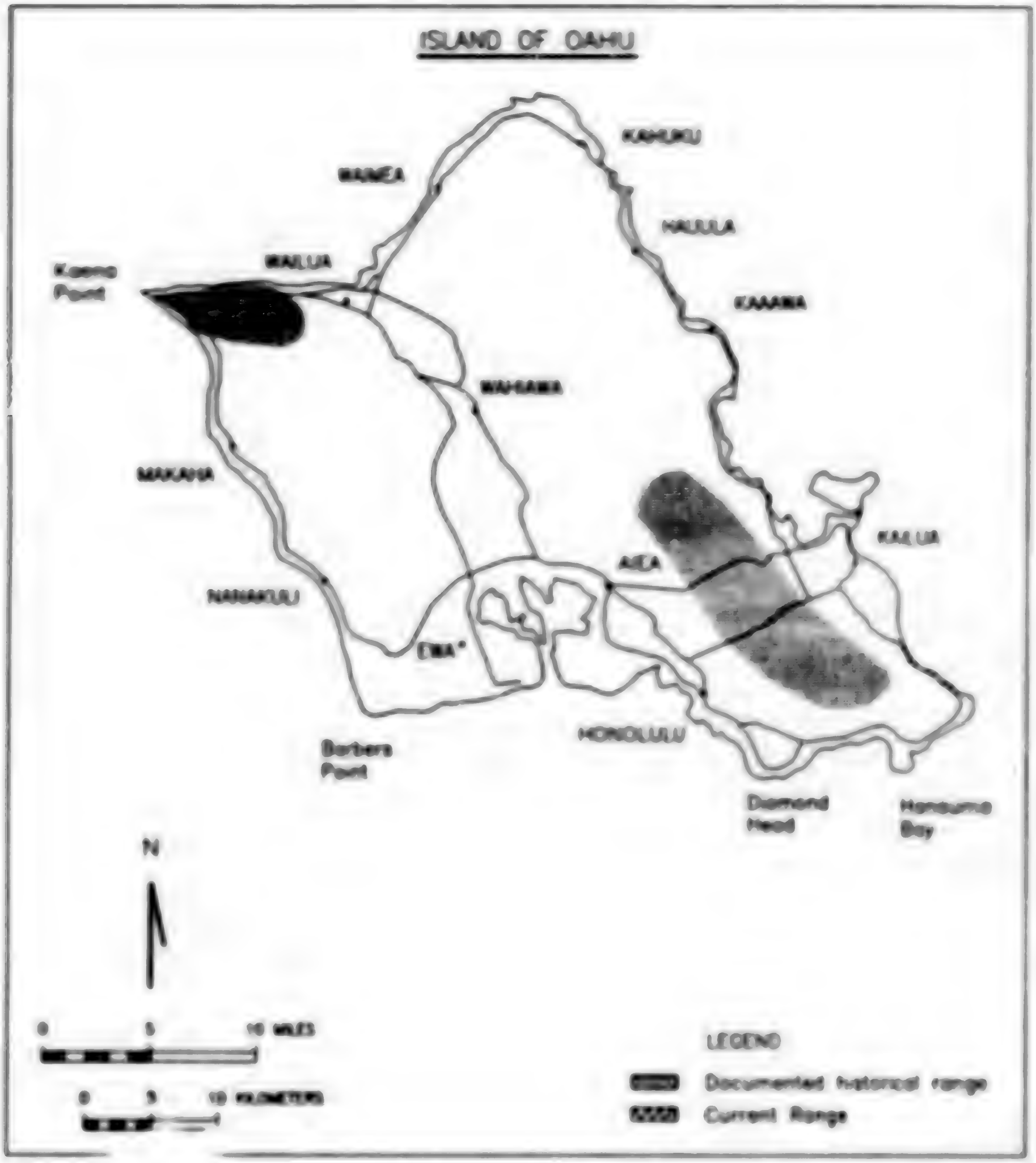
Historic and current range for *Alsinidendron trinerve*



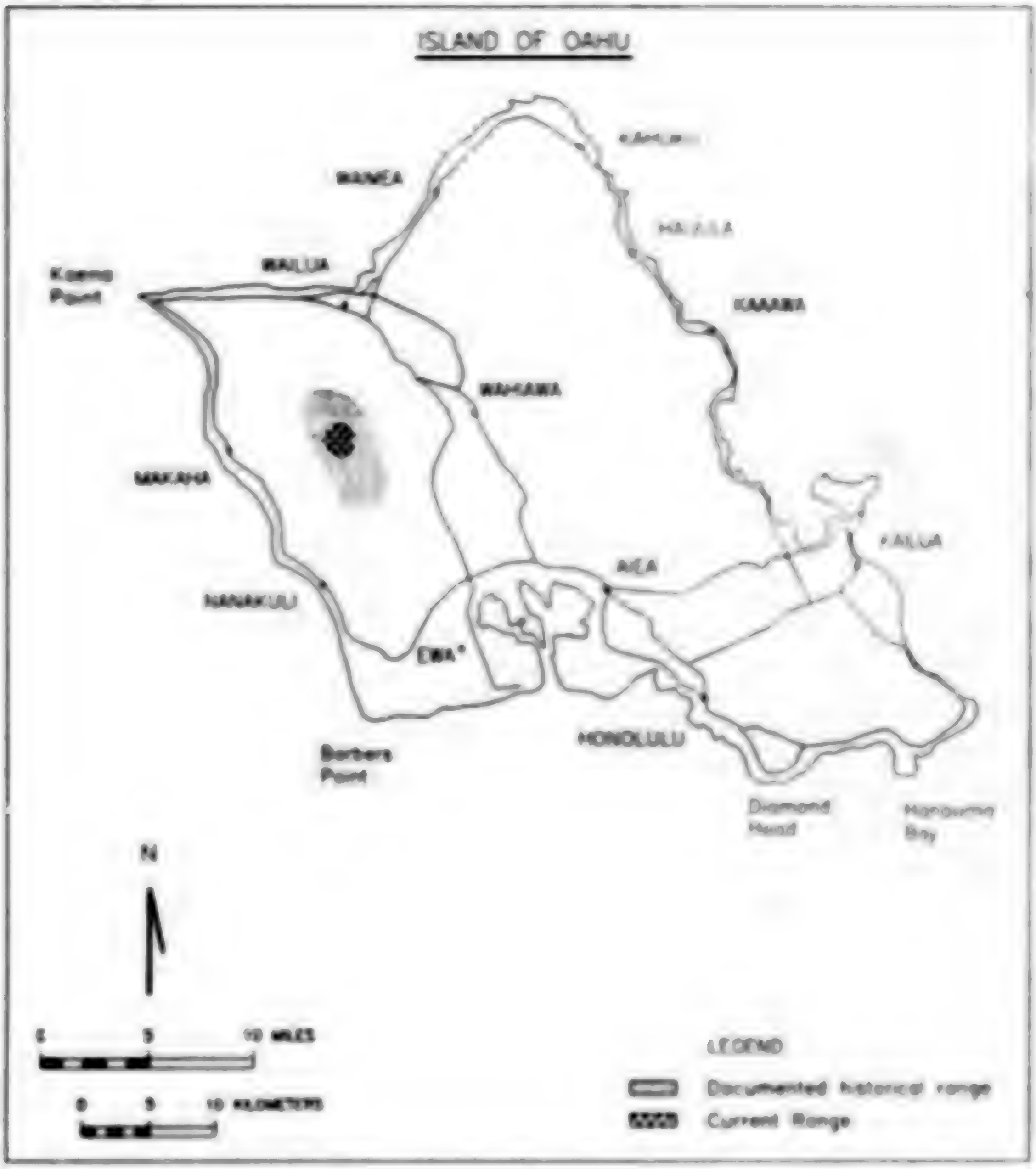
Historic and current range for *Centaurium sebaeoides*



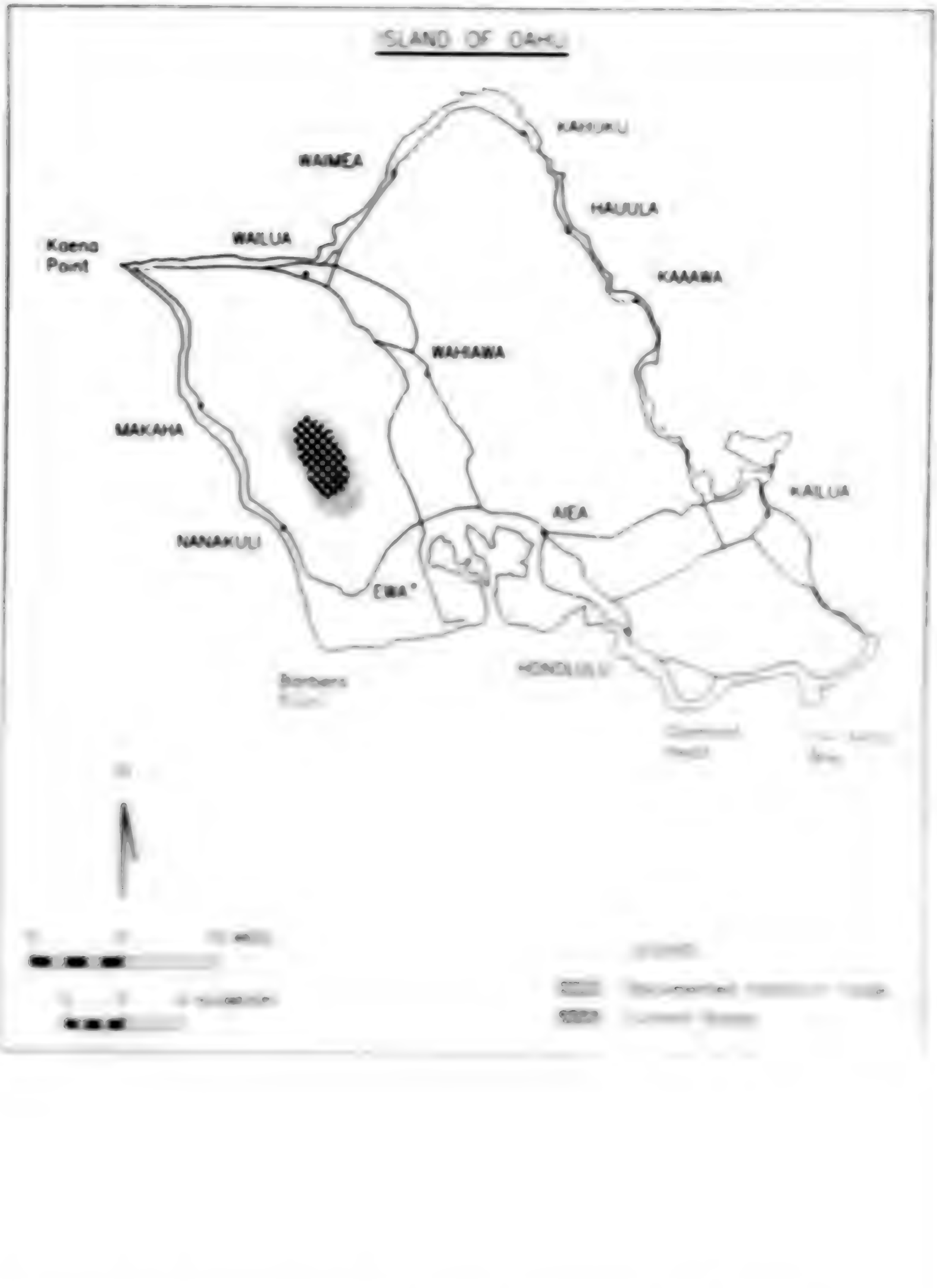
Historic and current range for Centaurium sebaeoides



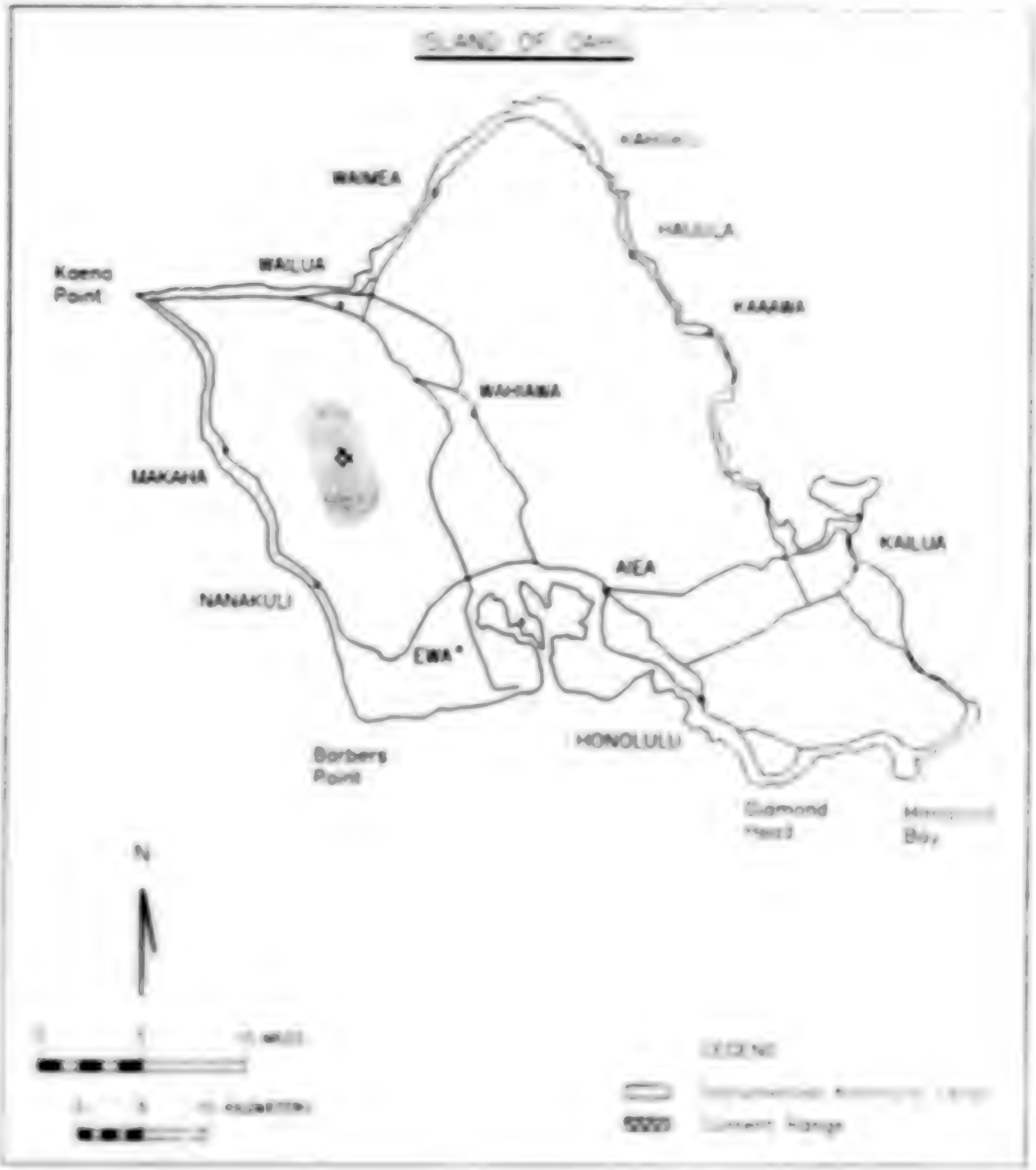
Historic and current range for *Chamaesyce celastroides* var. *kaenana*



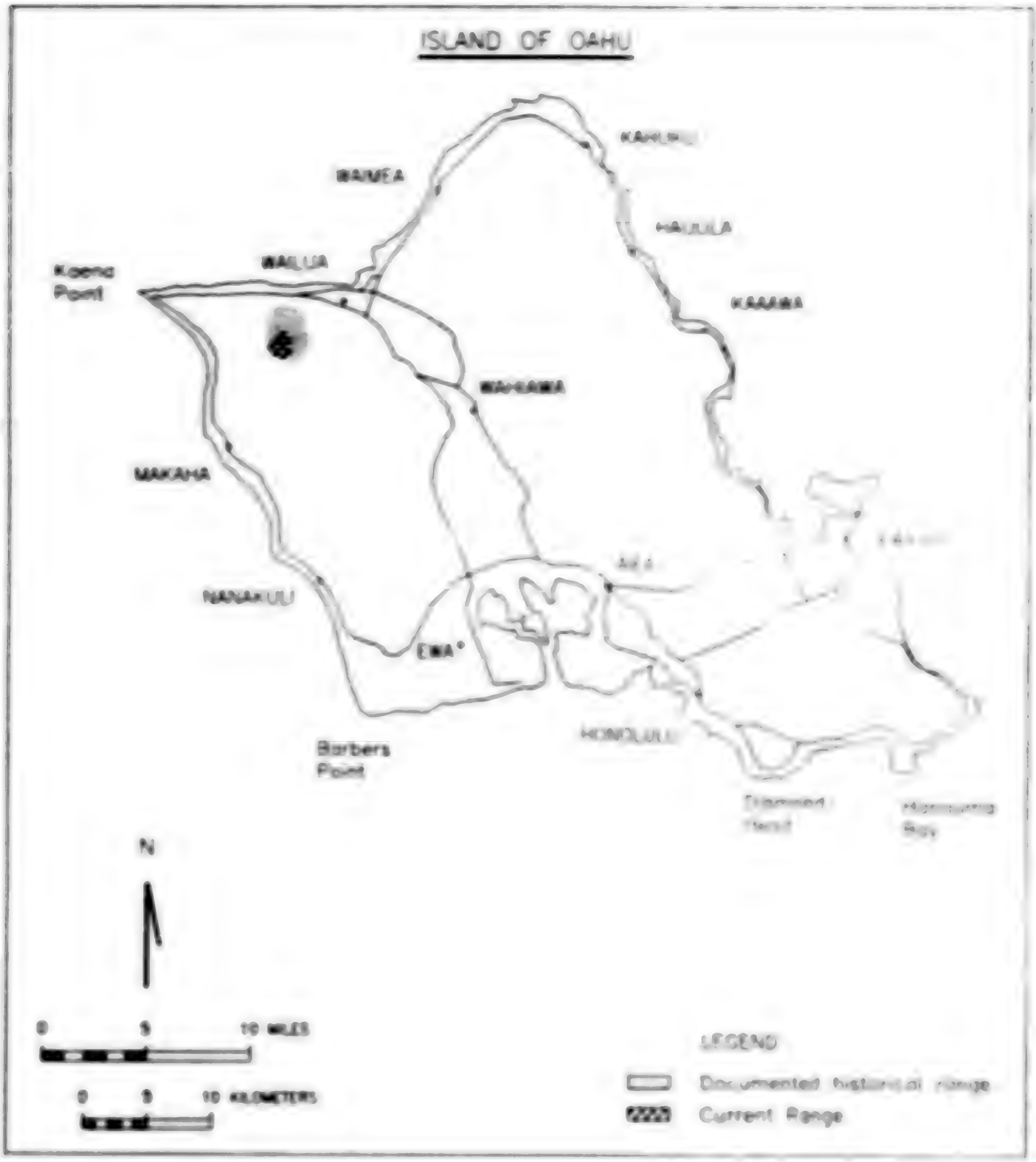
Historic and current range for *Chamaesyce kuwaleana*



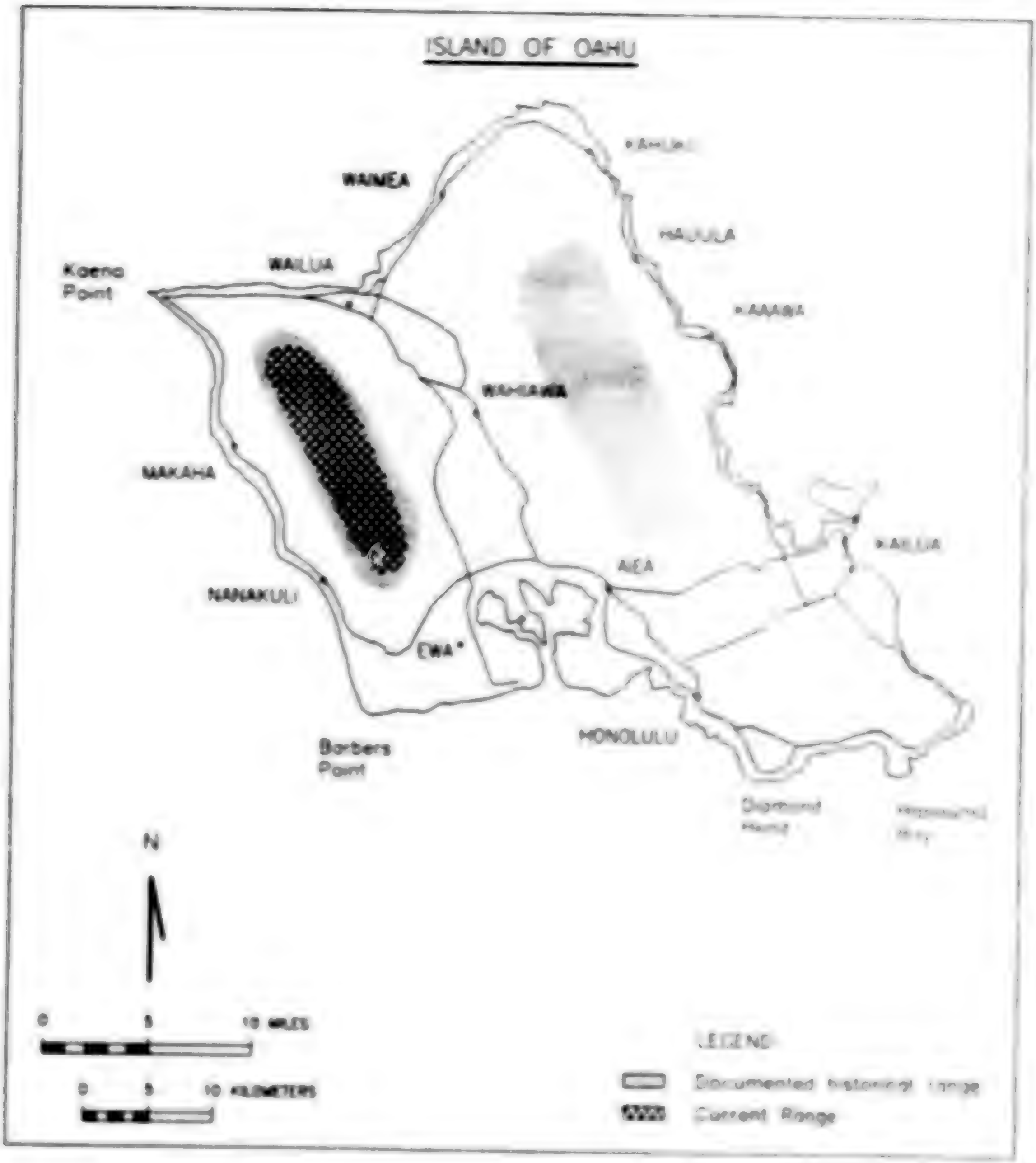
Historic and current range for *Cyanea grimesiana* ssp. *obatae*



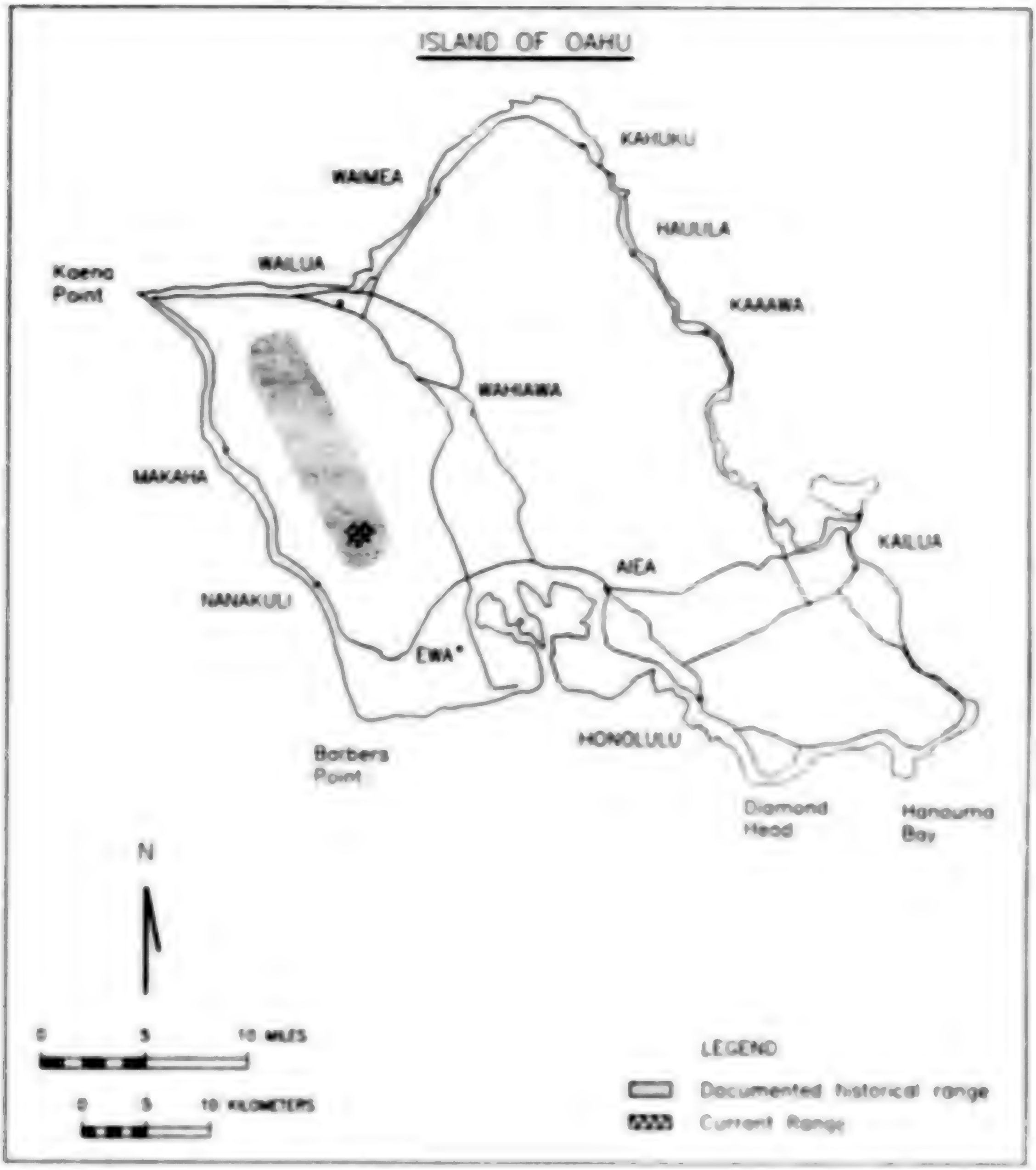
Historic and current range for *Cyanea pinnatifida*



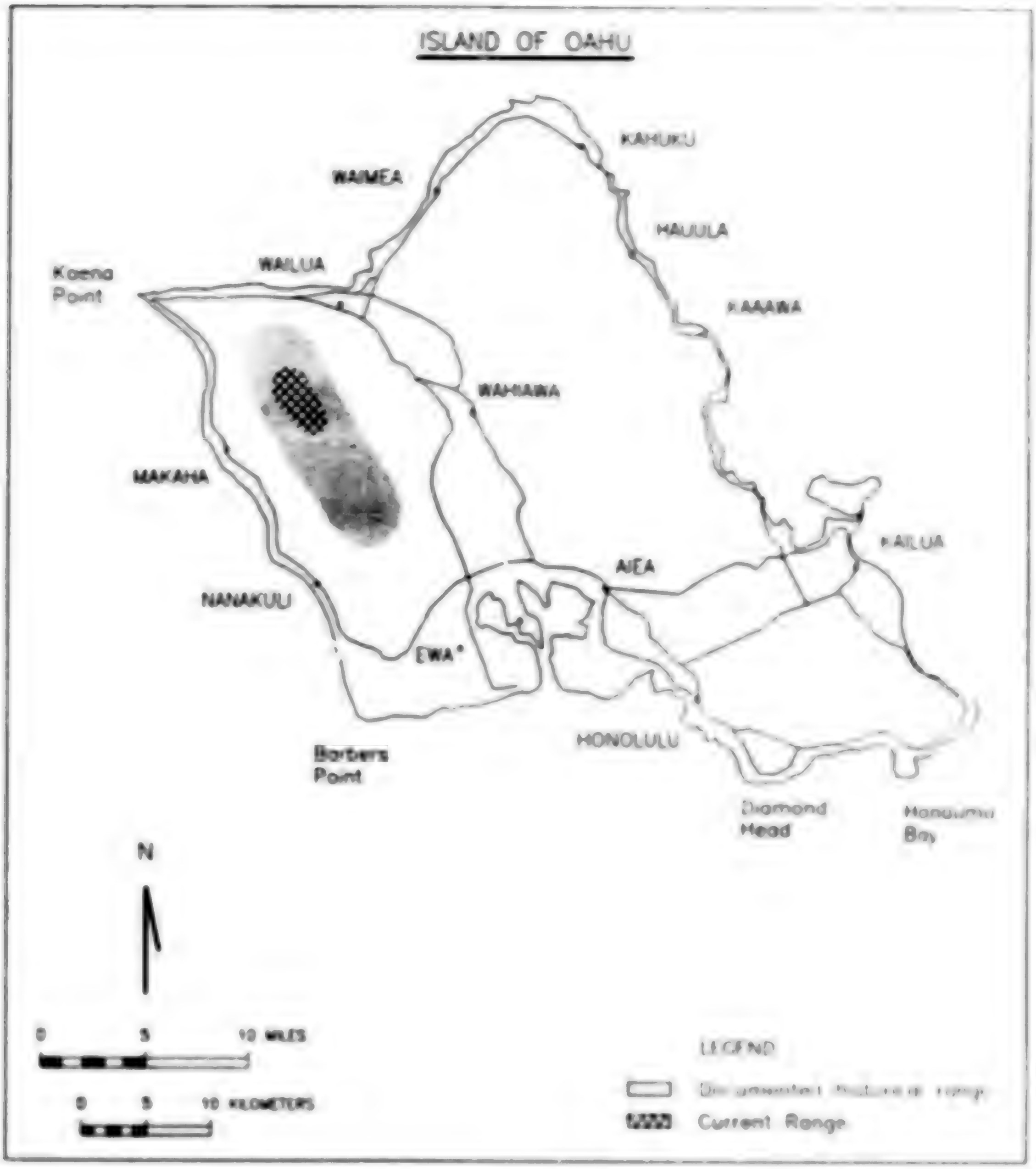
Historic and current range for *Cyanea superba*



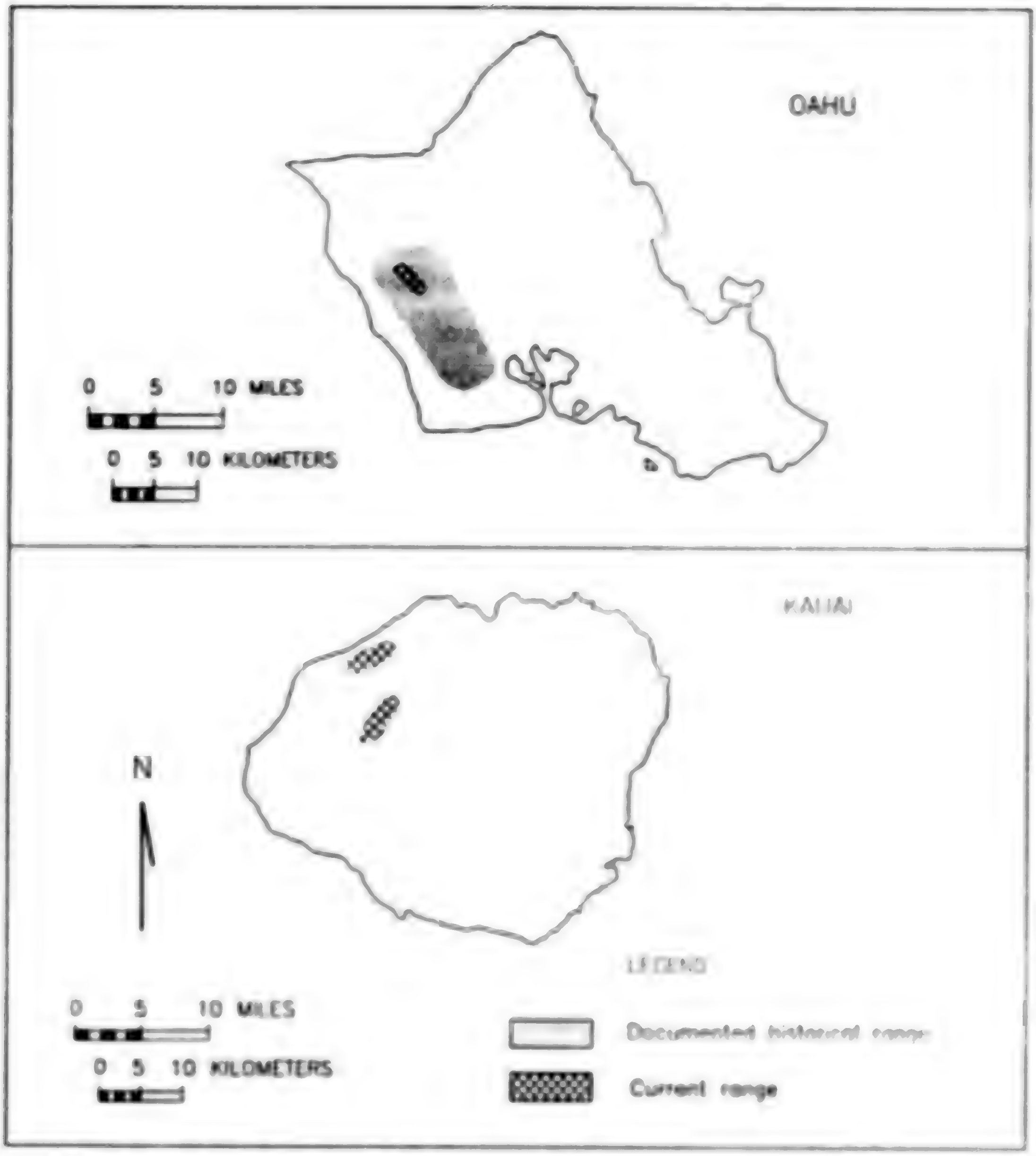
Historic and current range for *Diellia falcata*



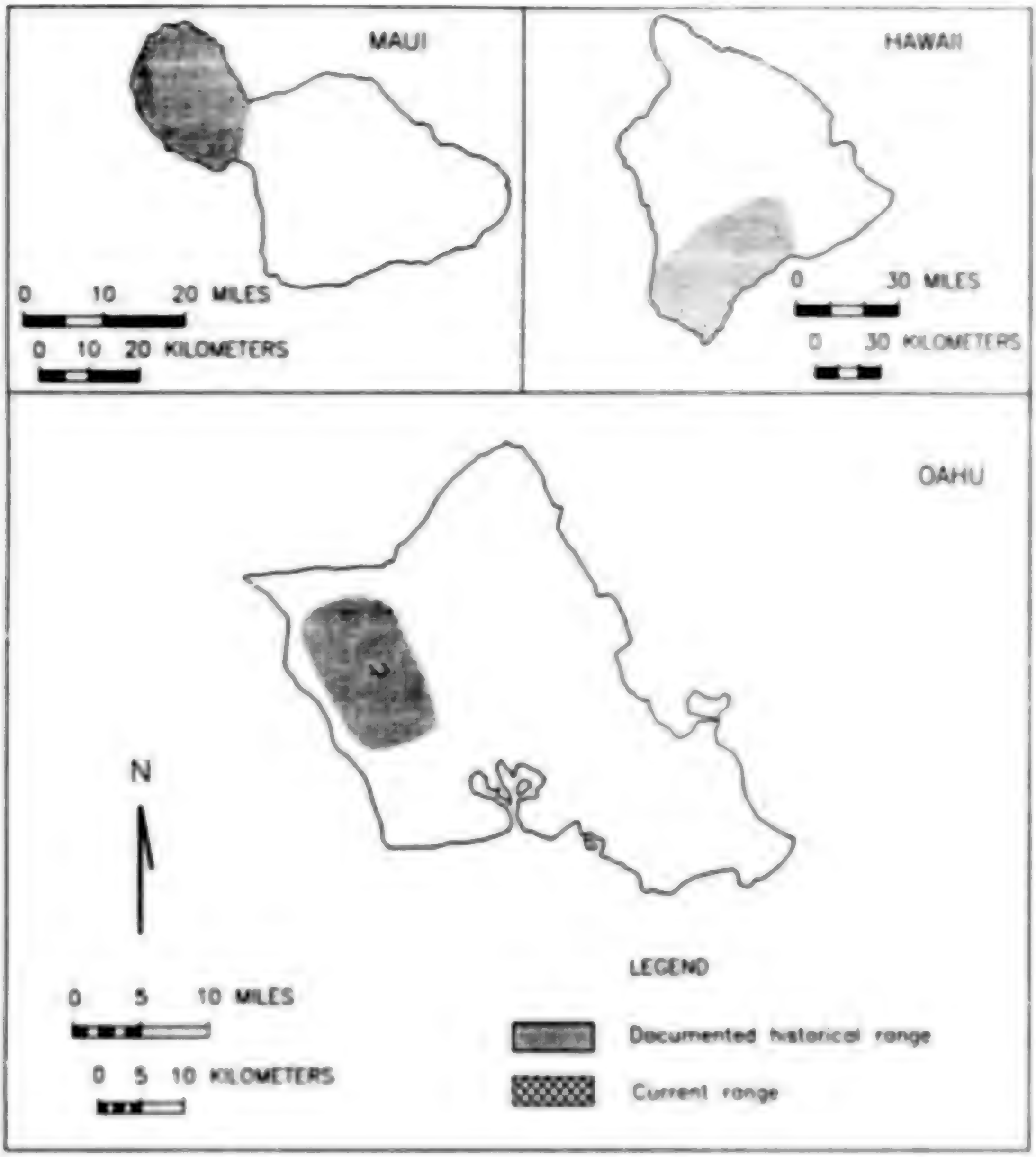
Historic and current range for *Diellia unisora*



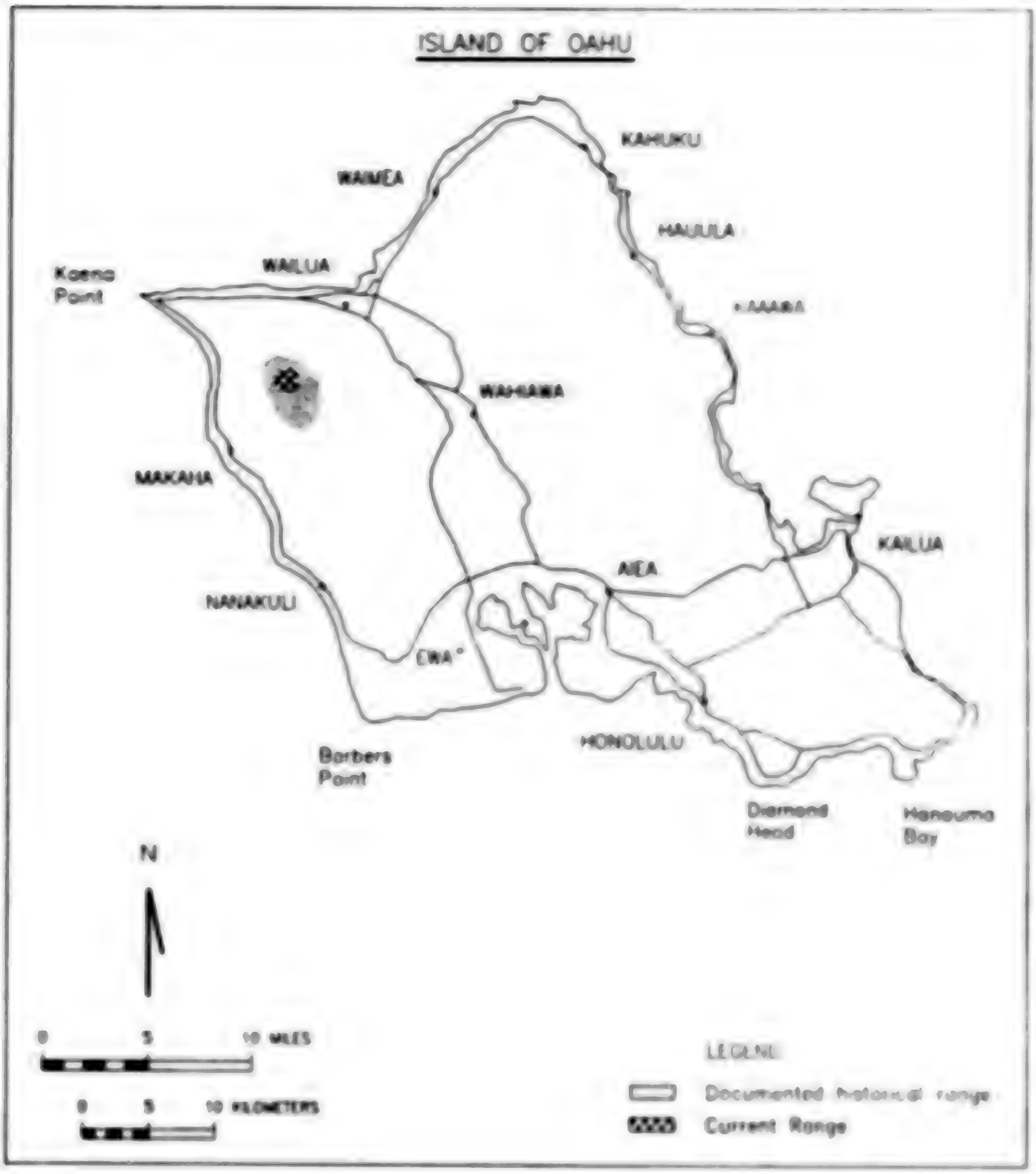
Historic and current range for *Dubautia herbstobatae*



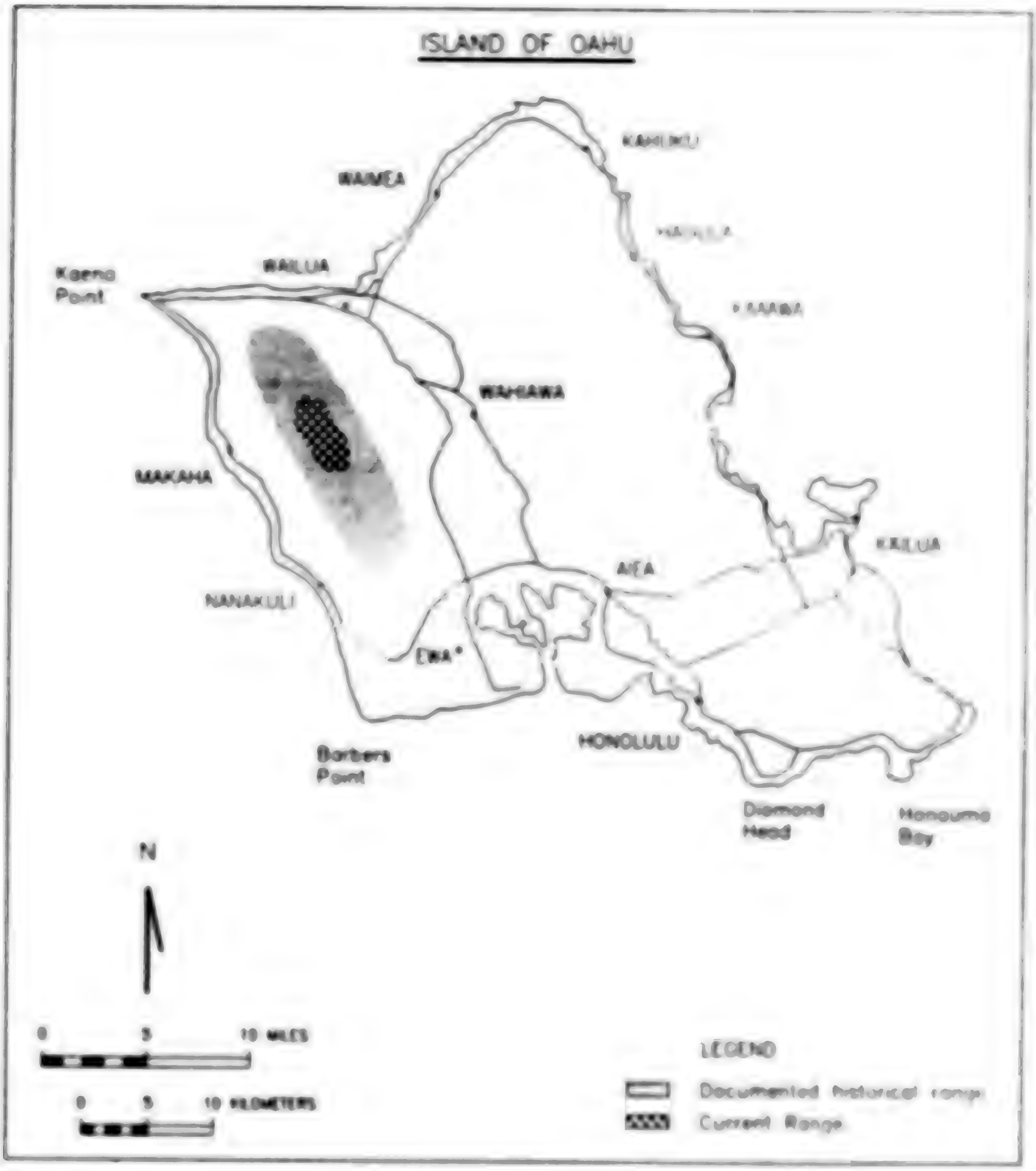
Historic and current range for Gouania meyenii



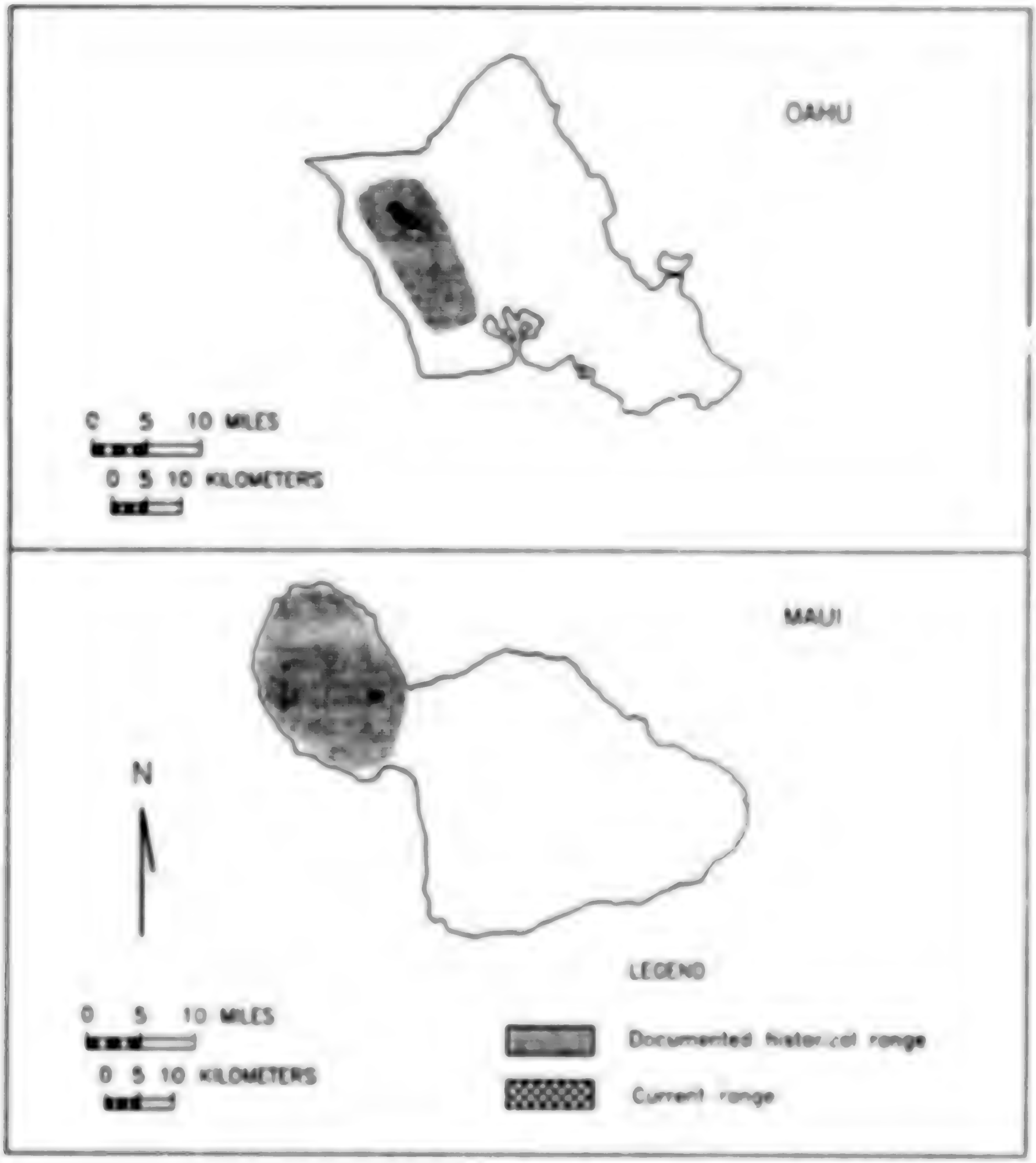
Historic and current range for Gouania vitifolia



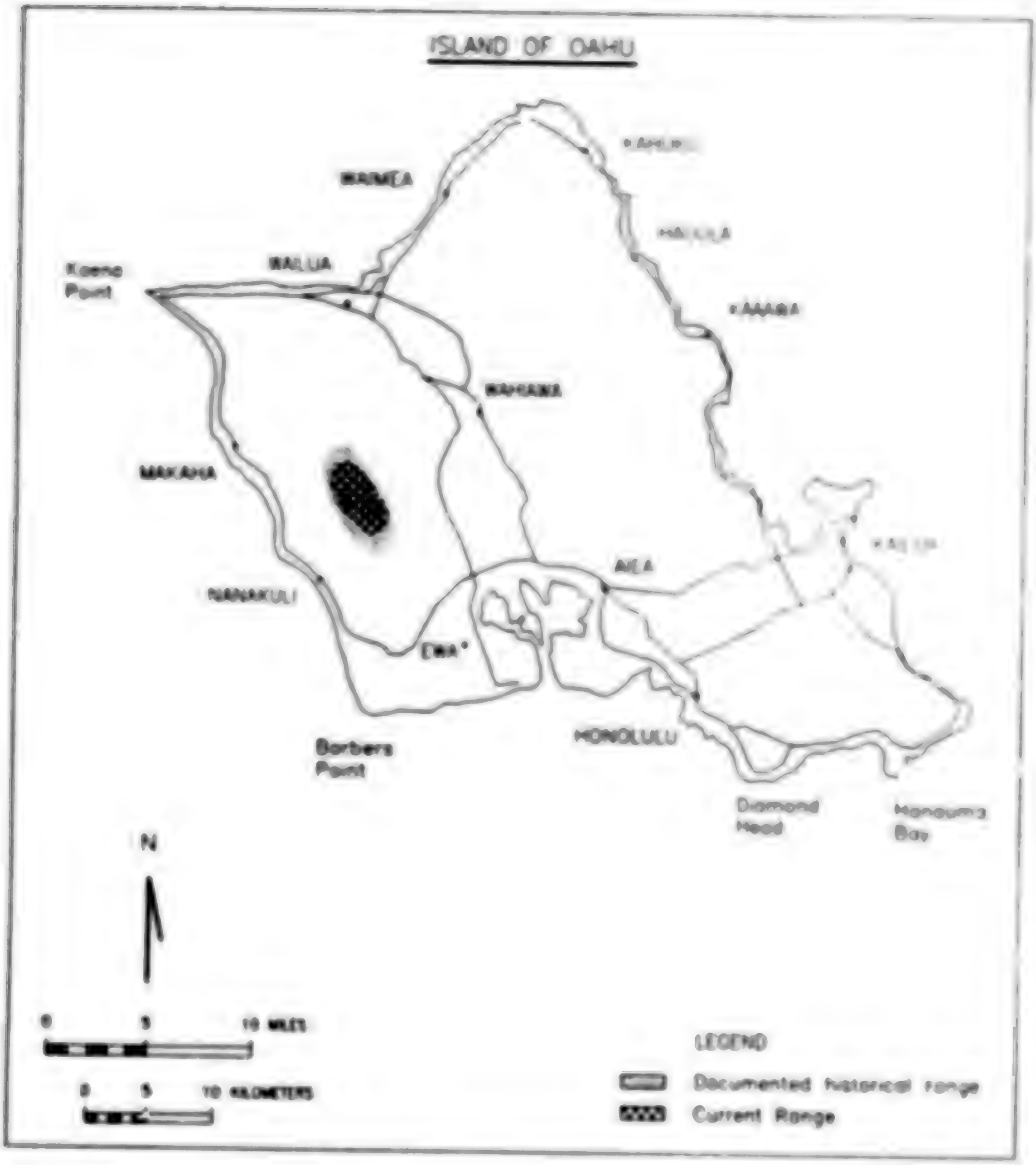
Historic and current range for *Hedyotis degeneri*



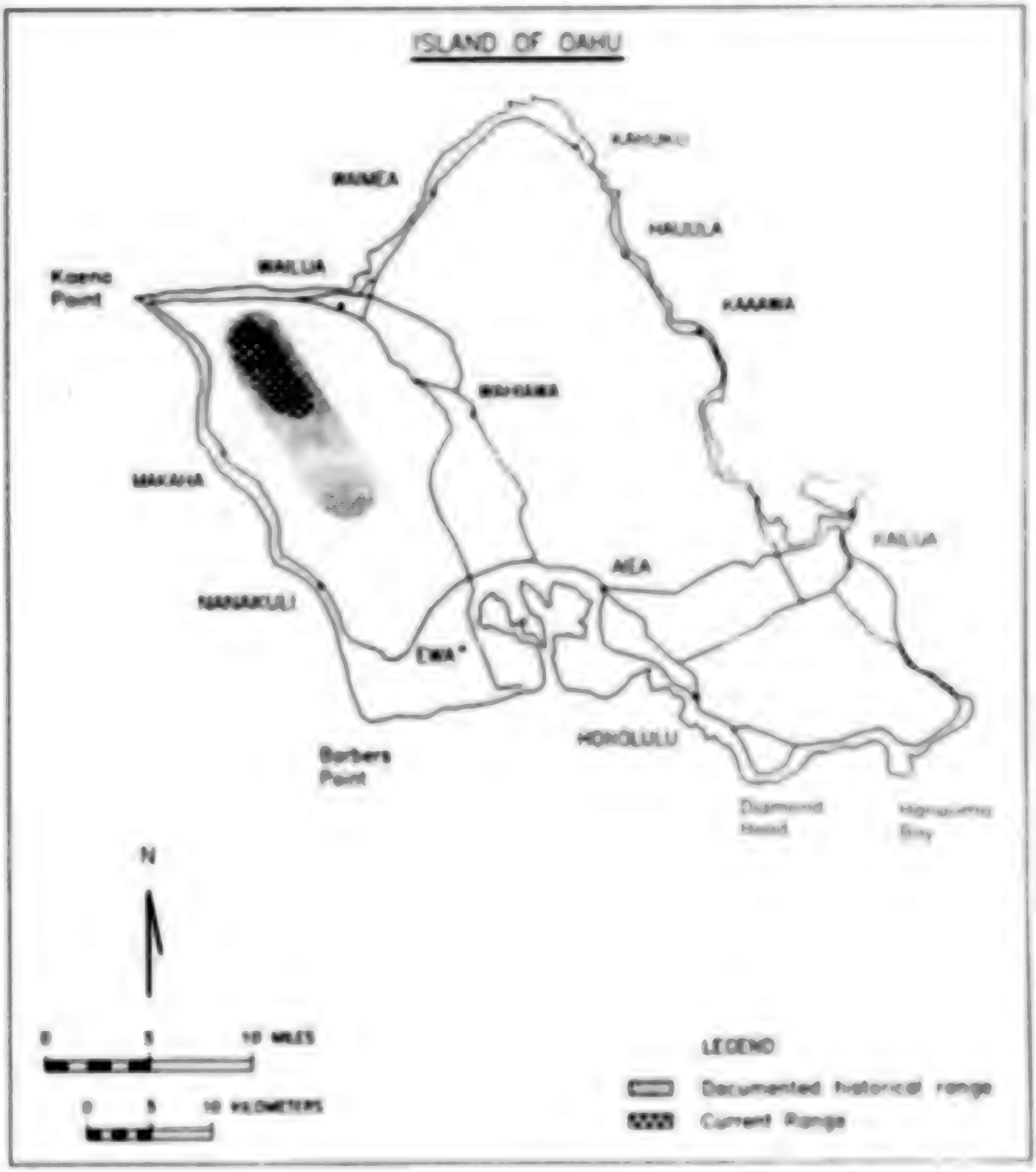
Historic and current range for *Hedyotis parvula*



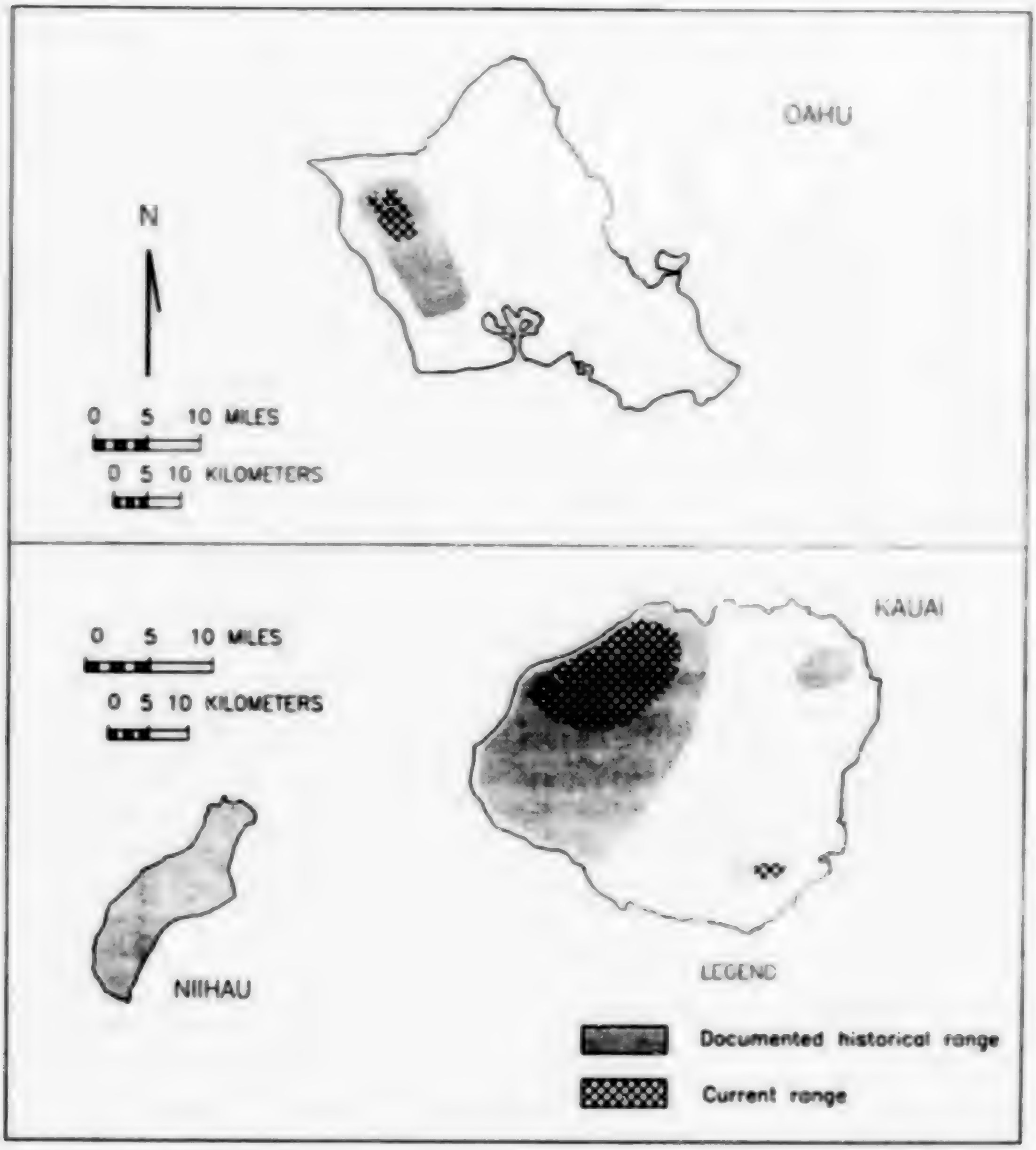
Historic and current range for *Hesperomannia arbuscula*



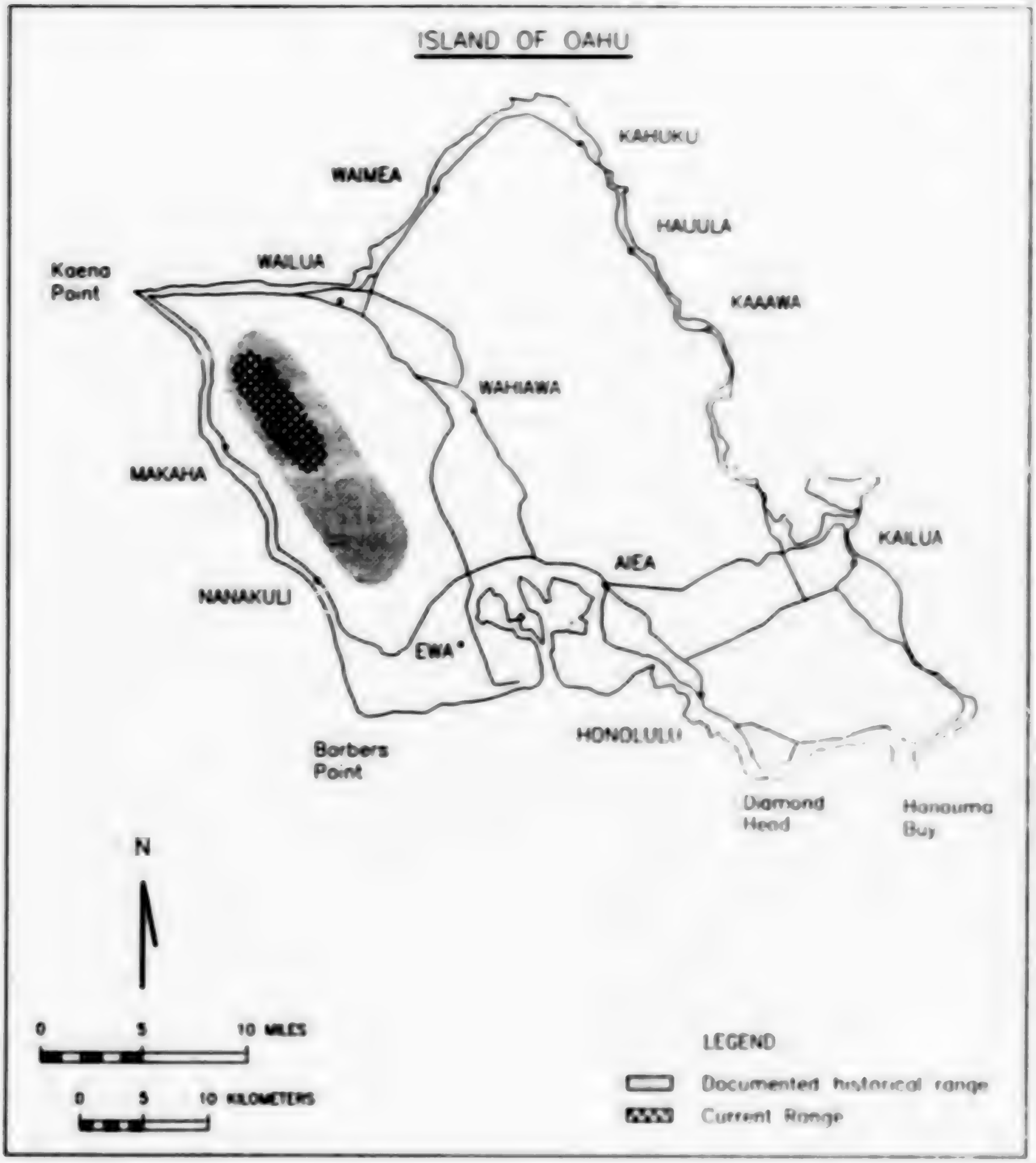
Historic and current range for *Lipochaeta lobata* var. *leptophylla*



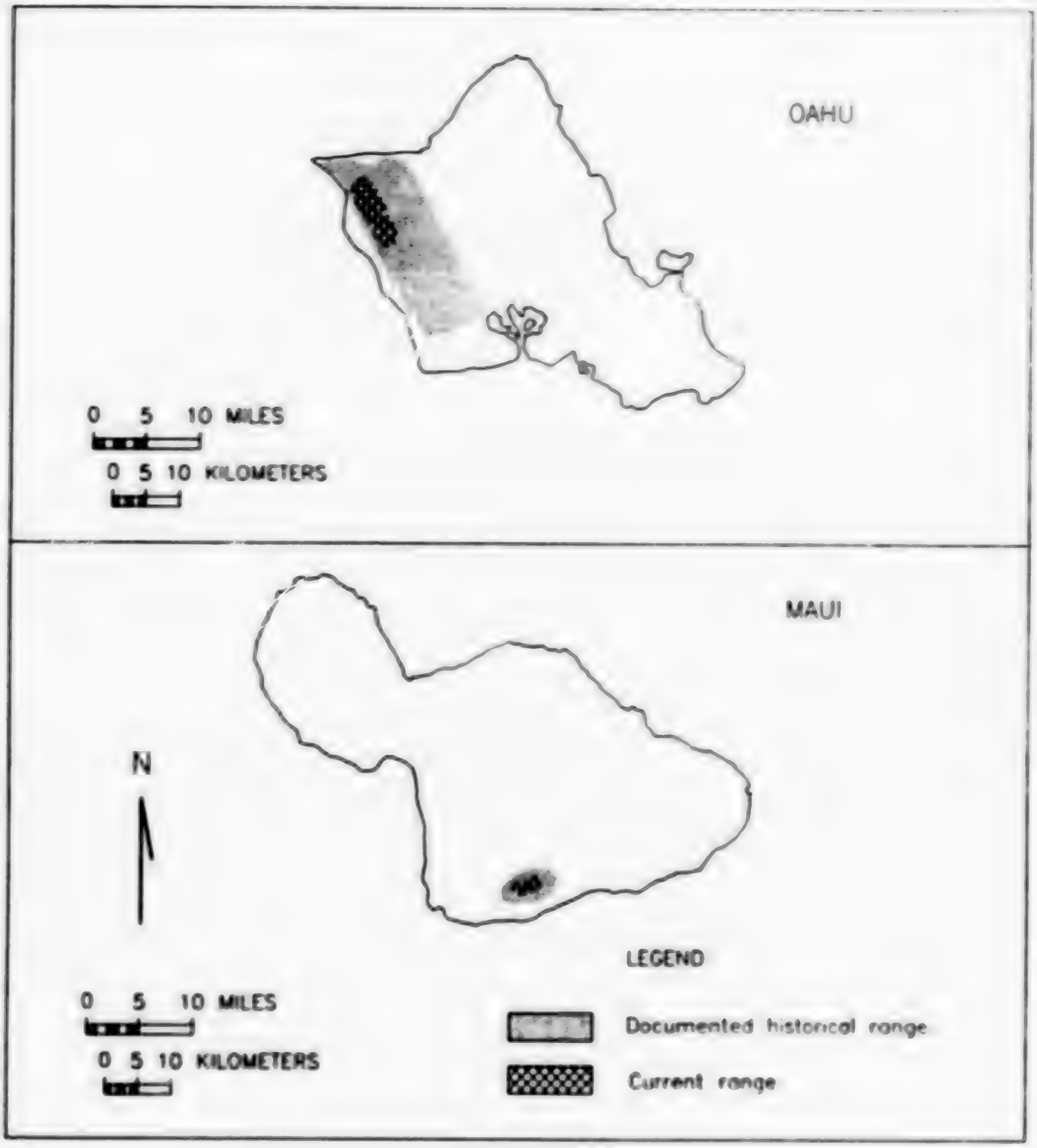
Historic and current range for *Lipochaeta tenuifolia*



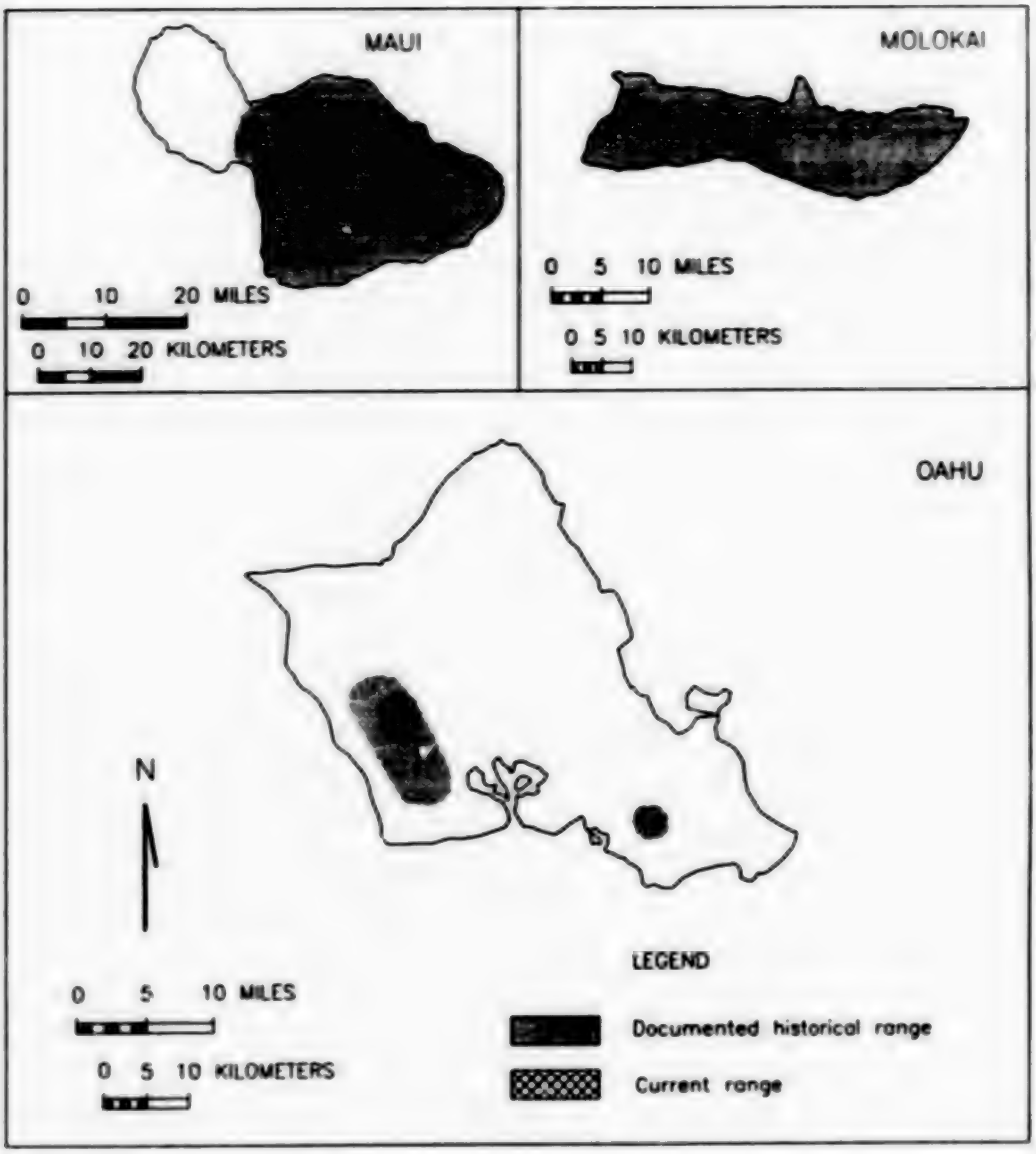
Historic and current range for *Lobelia niihauensis*



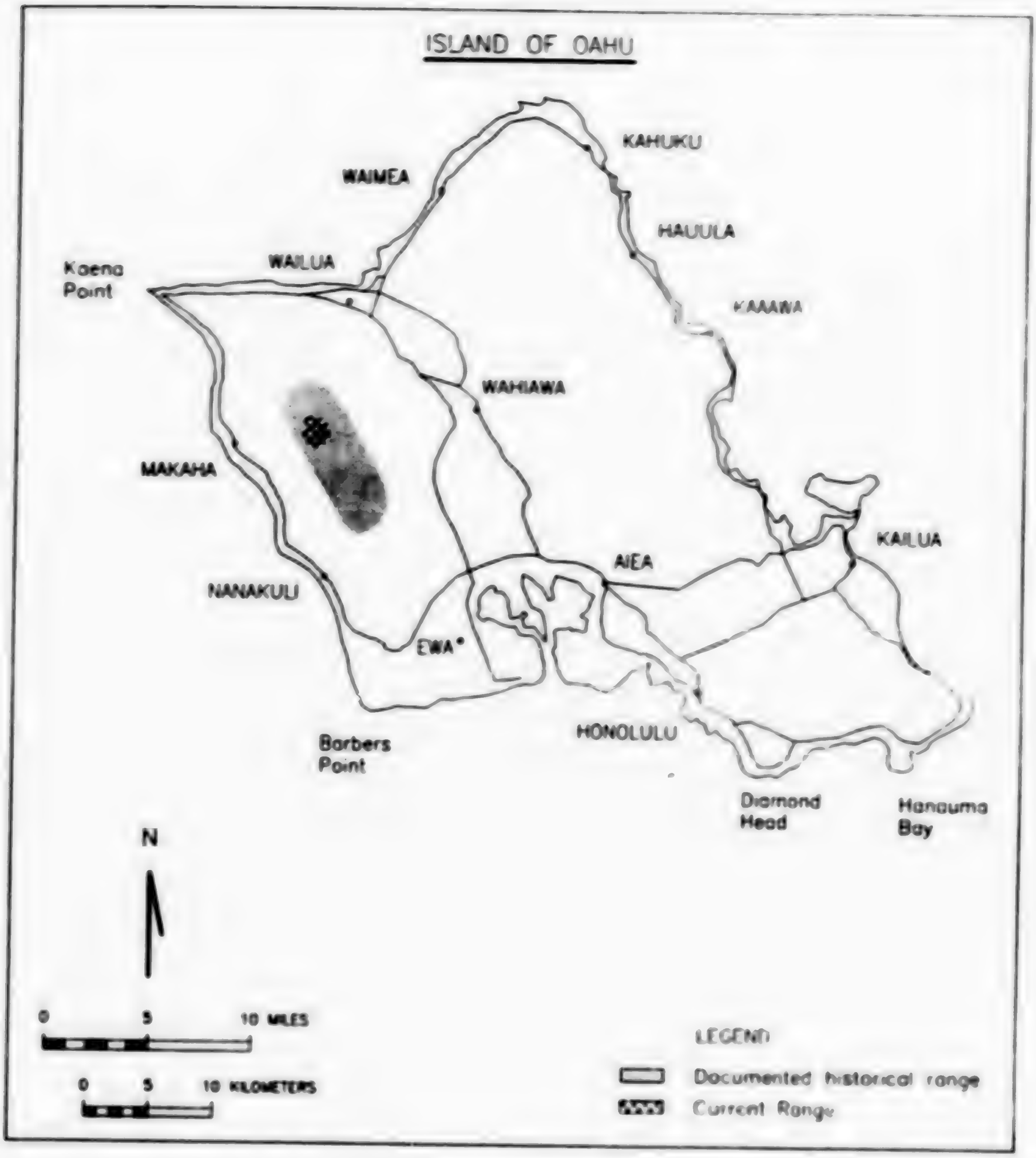
Historic and current range for *Neraudia angulata*



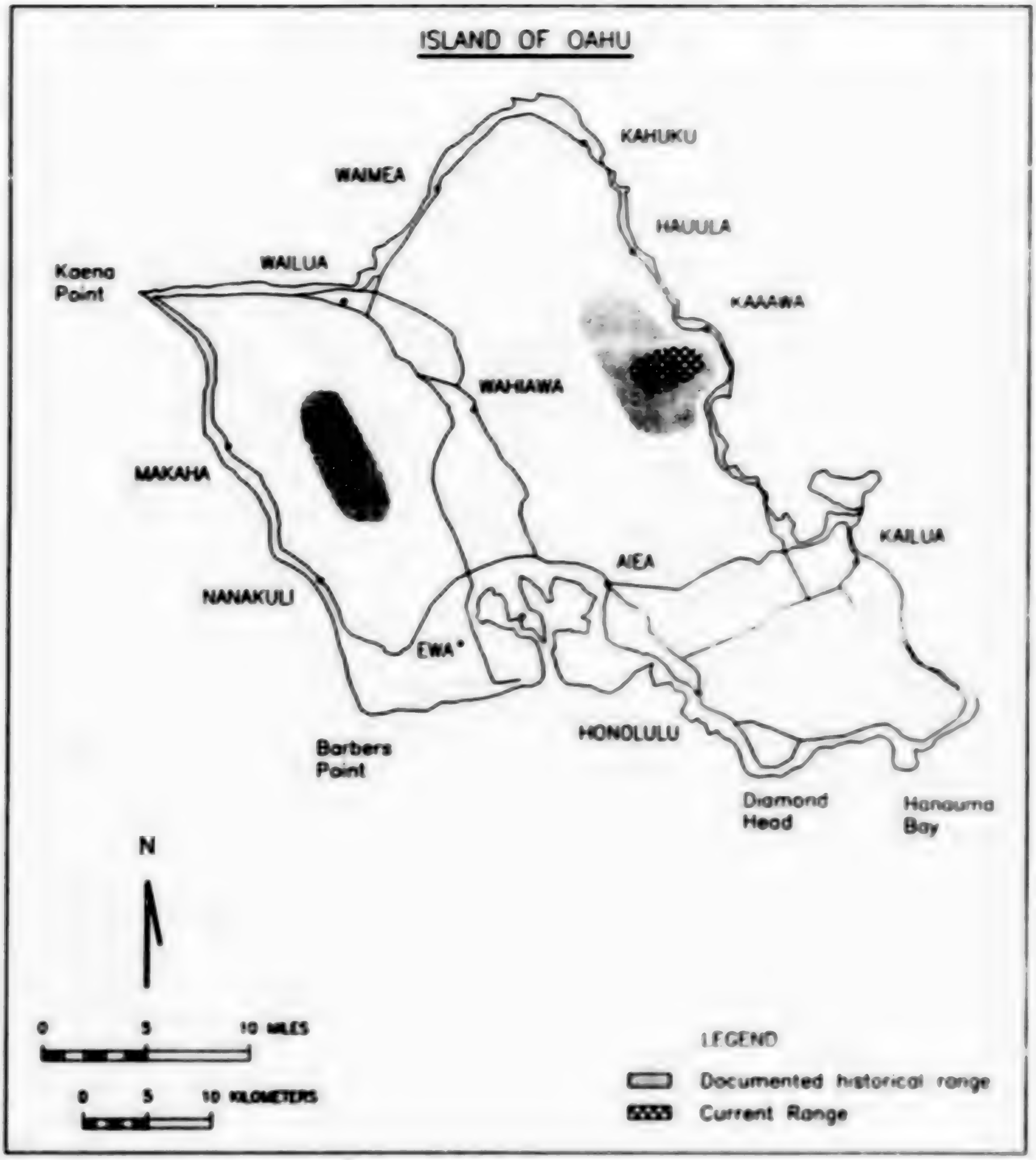
Historic and current range for *Nototrichium humile*



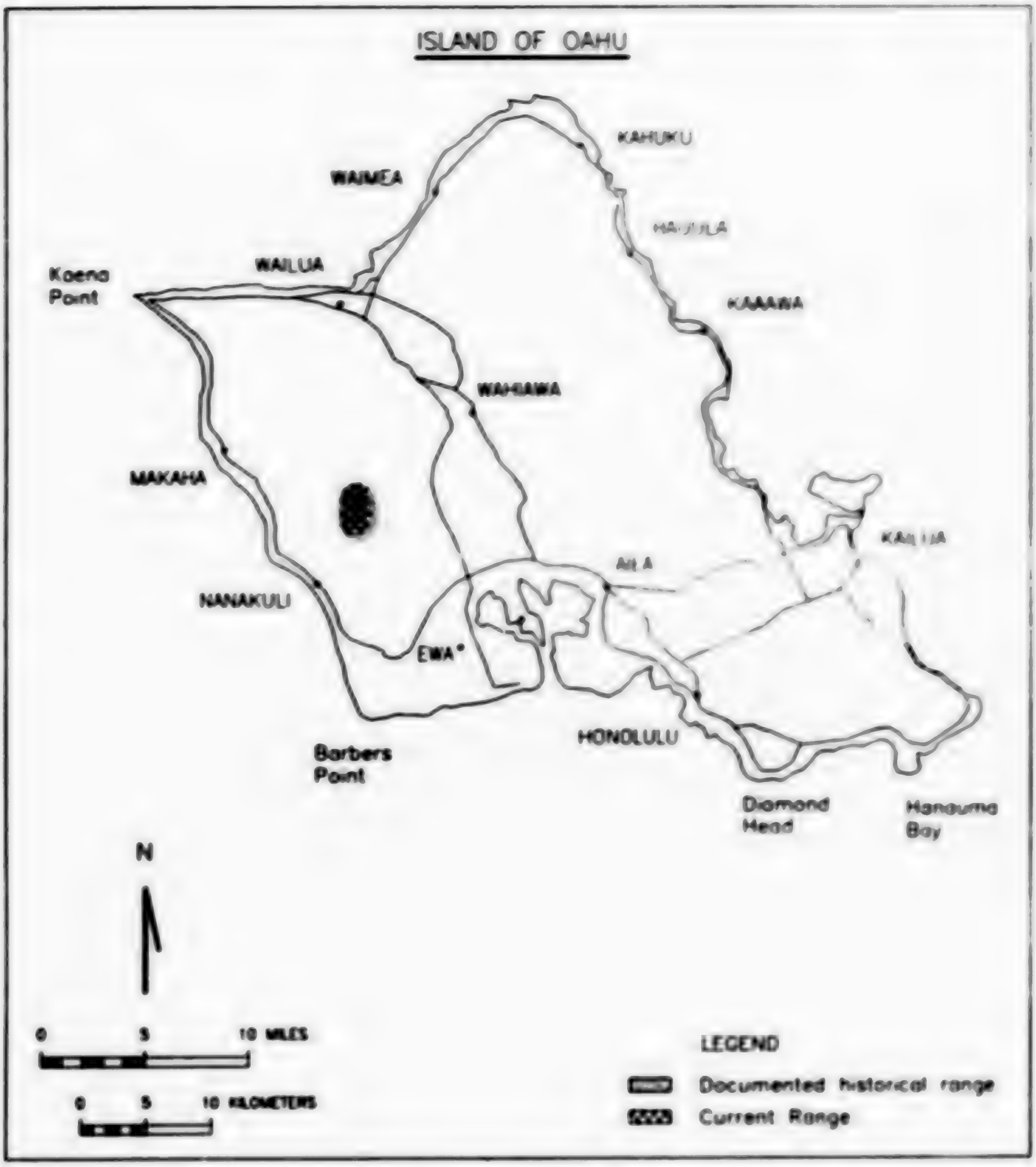
Historic and current range for *Phyllostegia mollis*



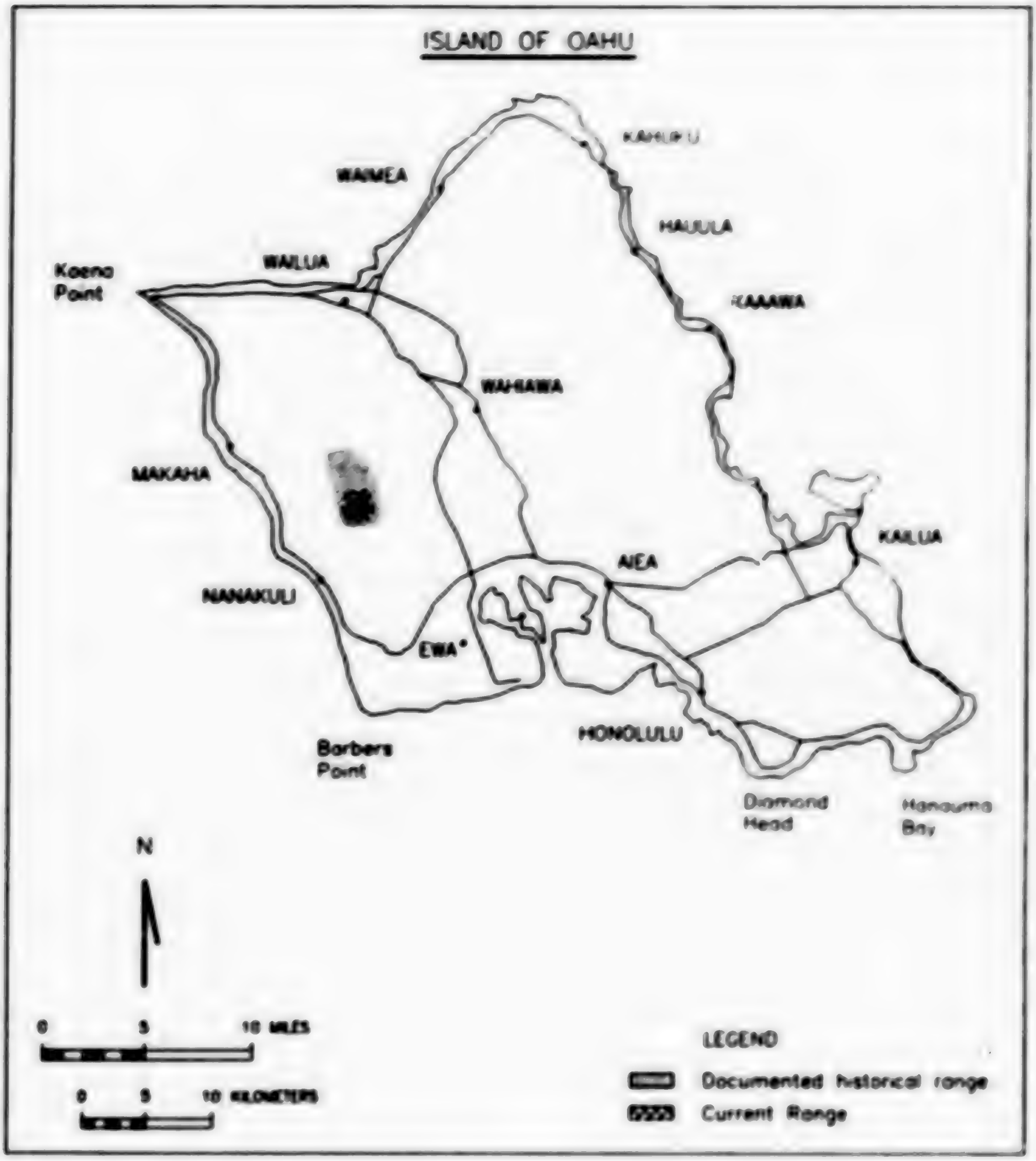
Historic and current range for *Sanicula mariversa*



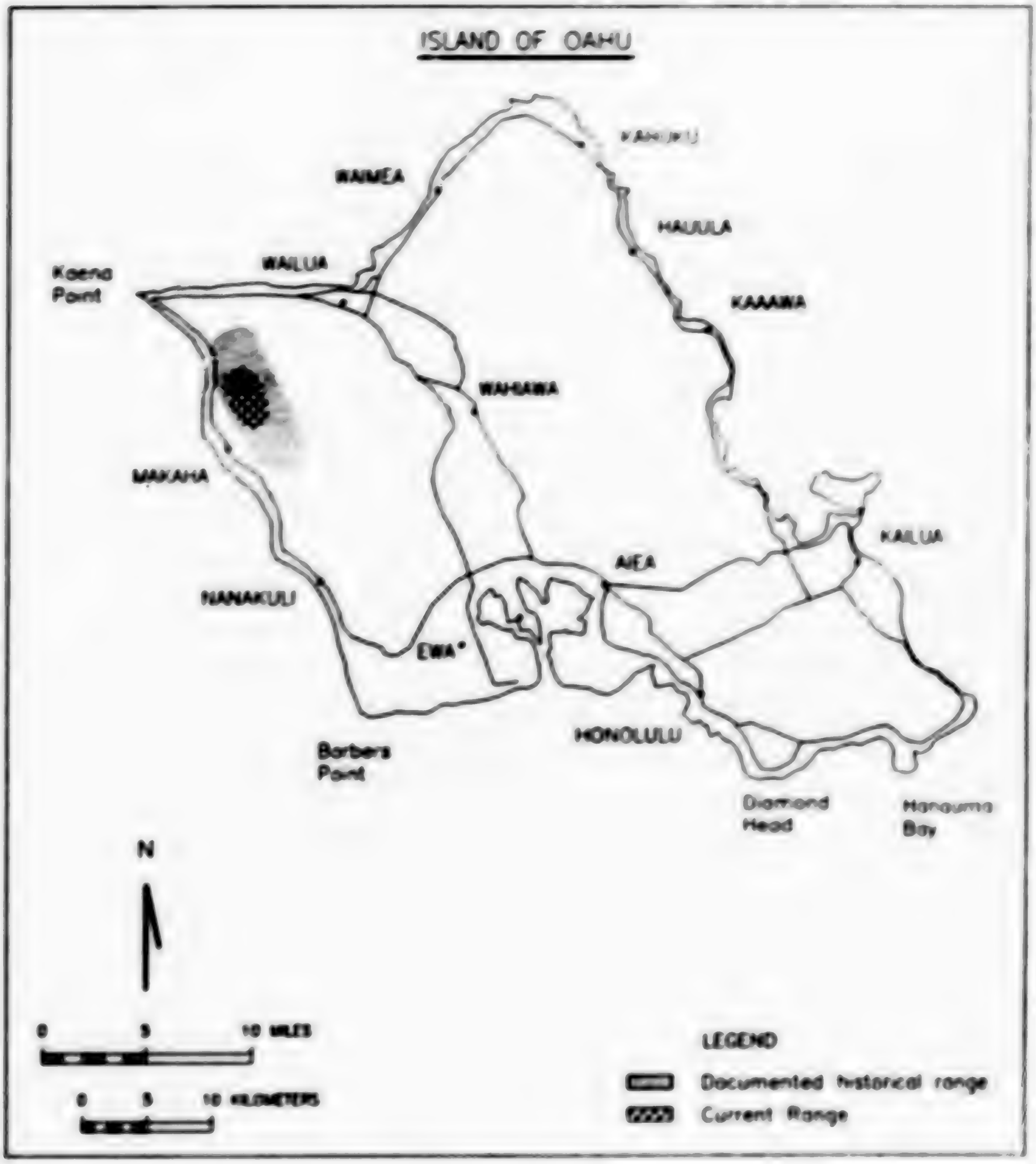
Historic and current range for *Schiedea kaalae*



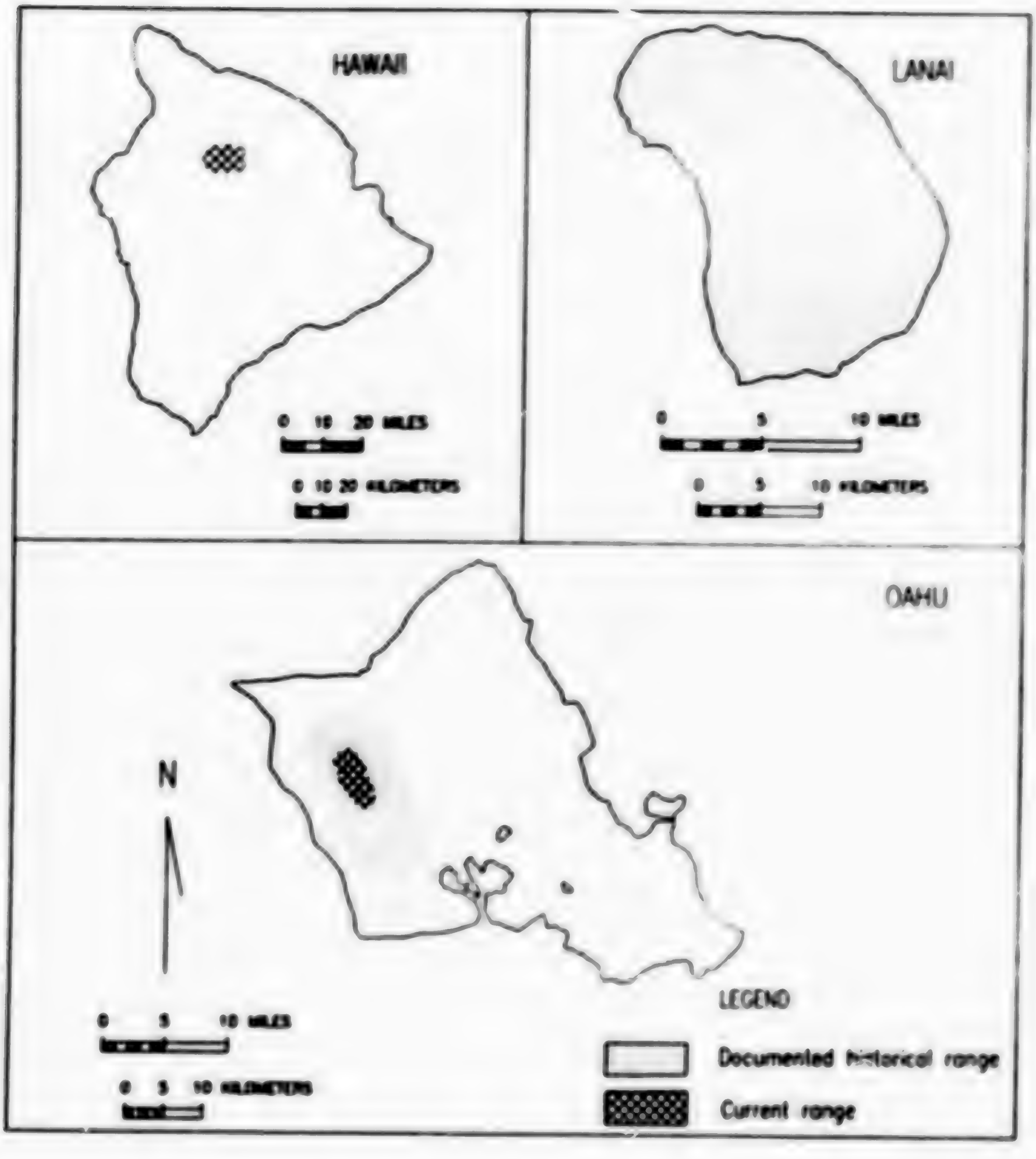
Historic and current range for *Silene perlmanii*



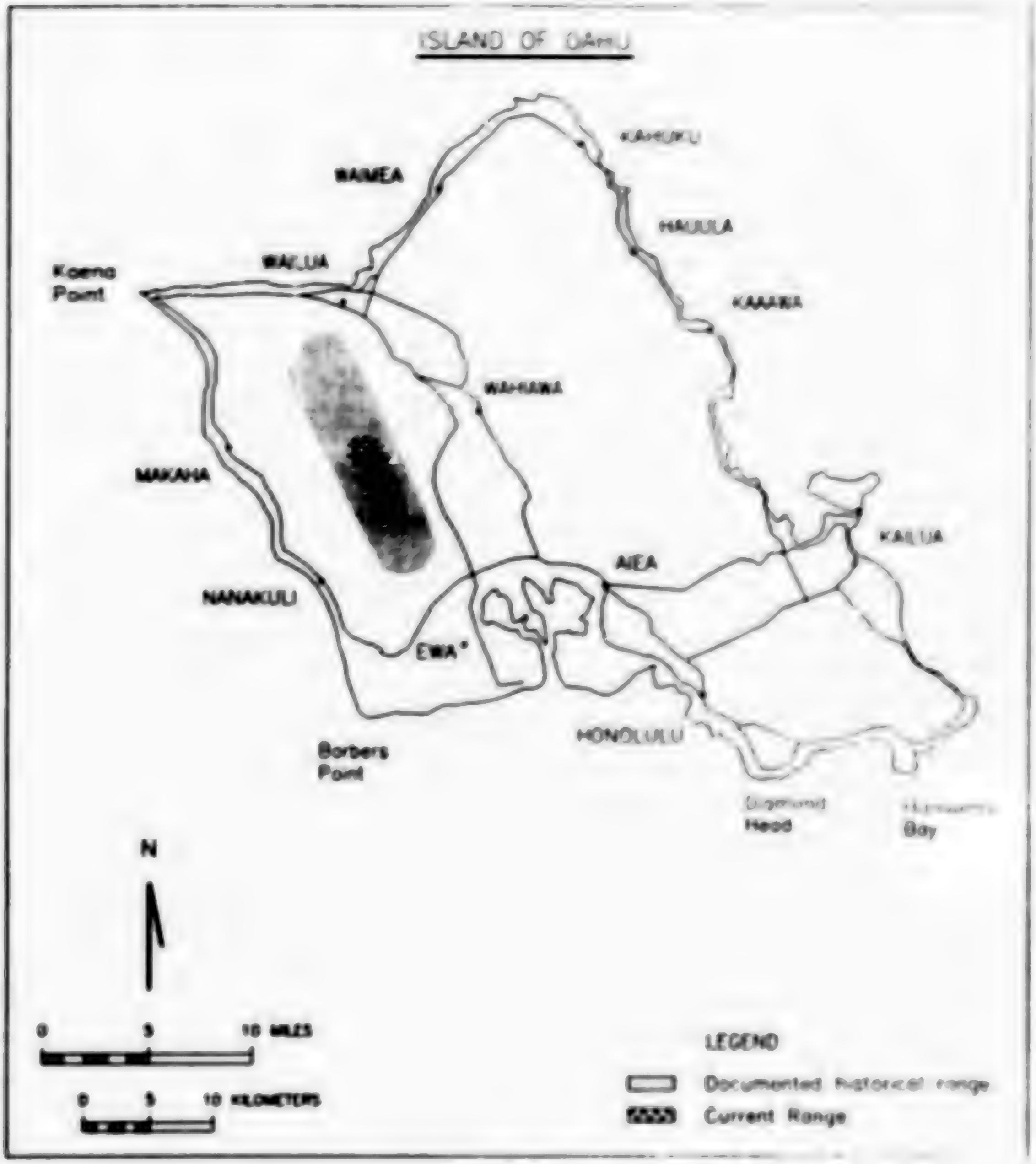
Historic and current range for *Stenogyne kanehoana*



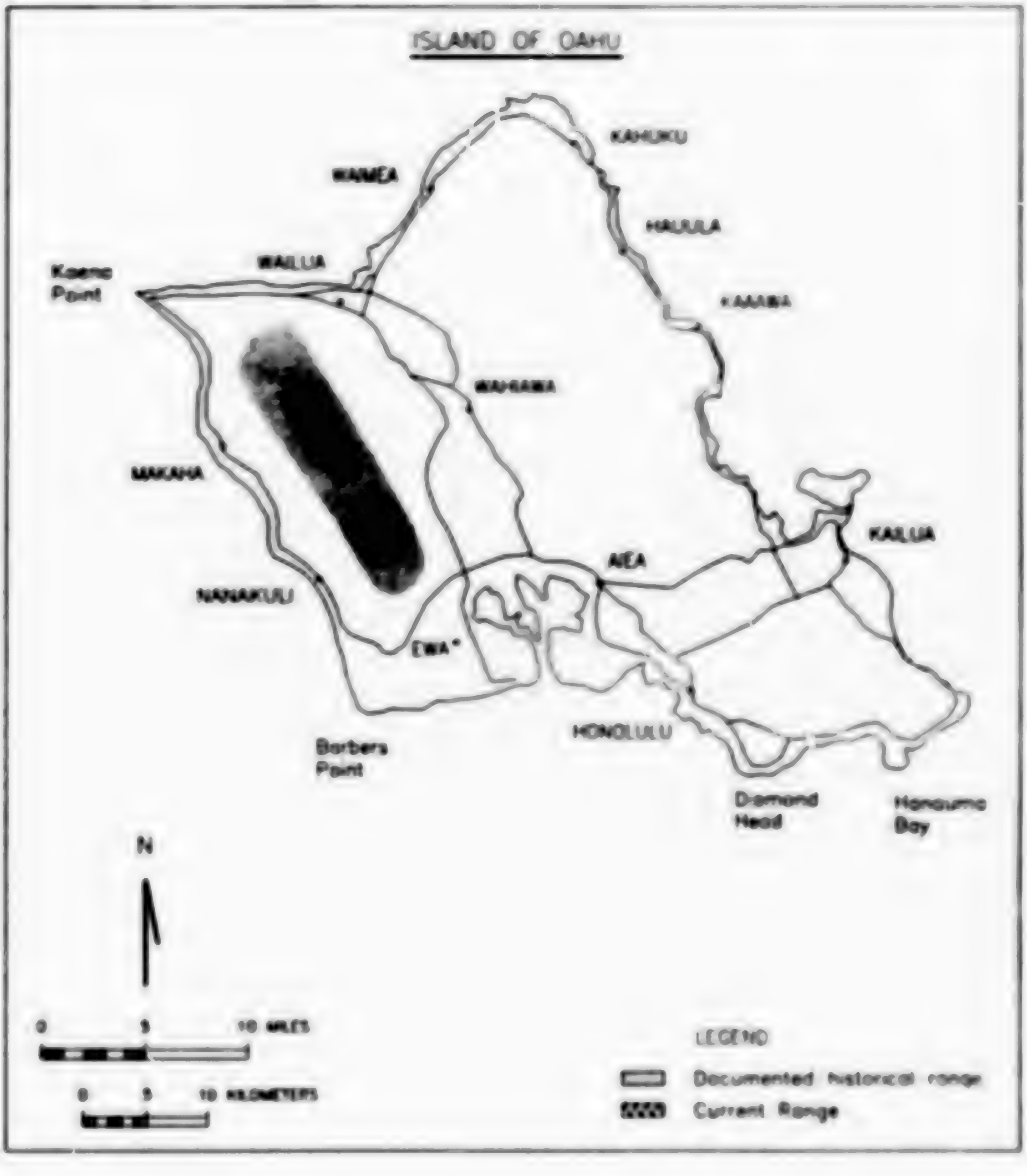
Historic and current range for *Tetramolopium filiforme*



Historic and current range for *Tetramolopium lepidotum* spp. *lepidotum*

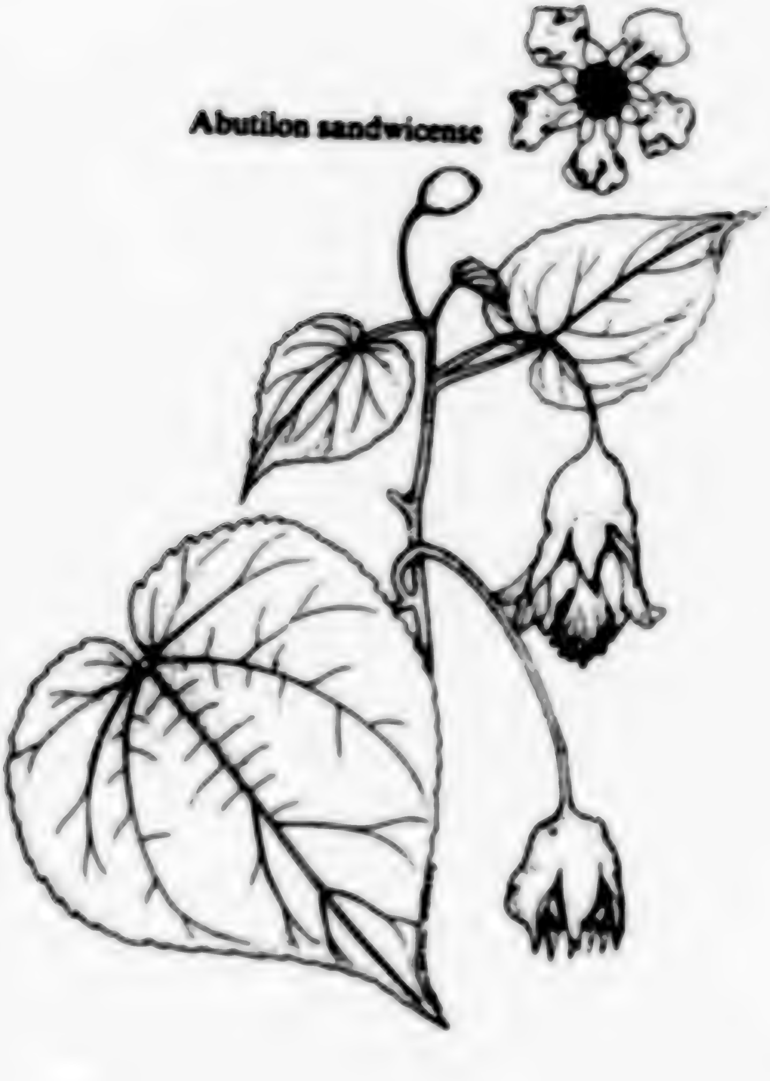


Historic and current range for *Urera kaalae*

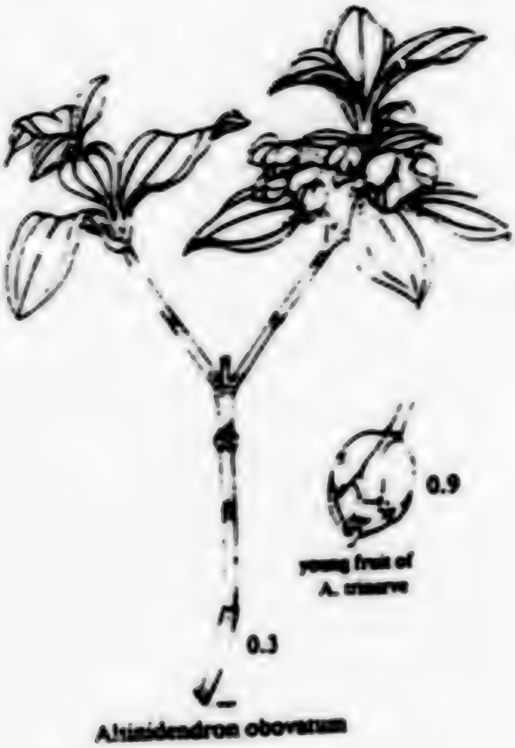


Historic and current range for *Viola chamissoniana* spp. *chamissoniana*

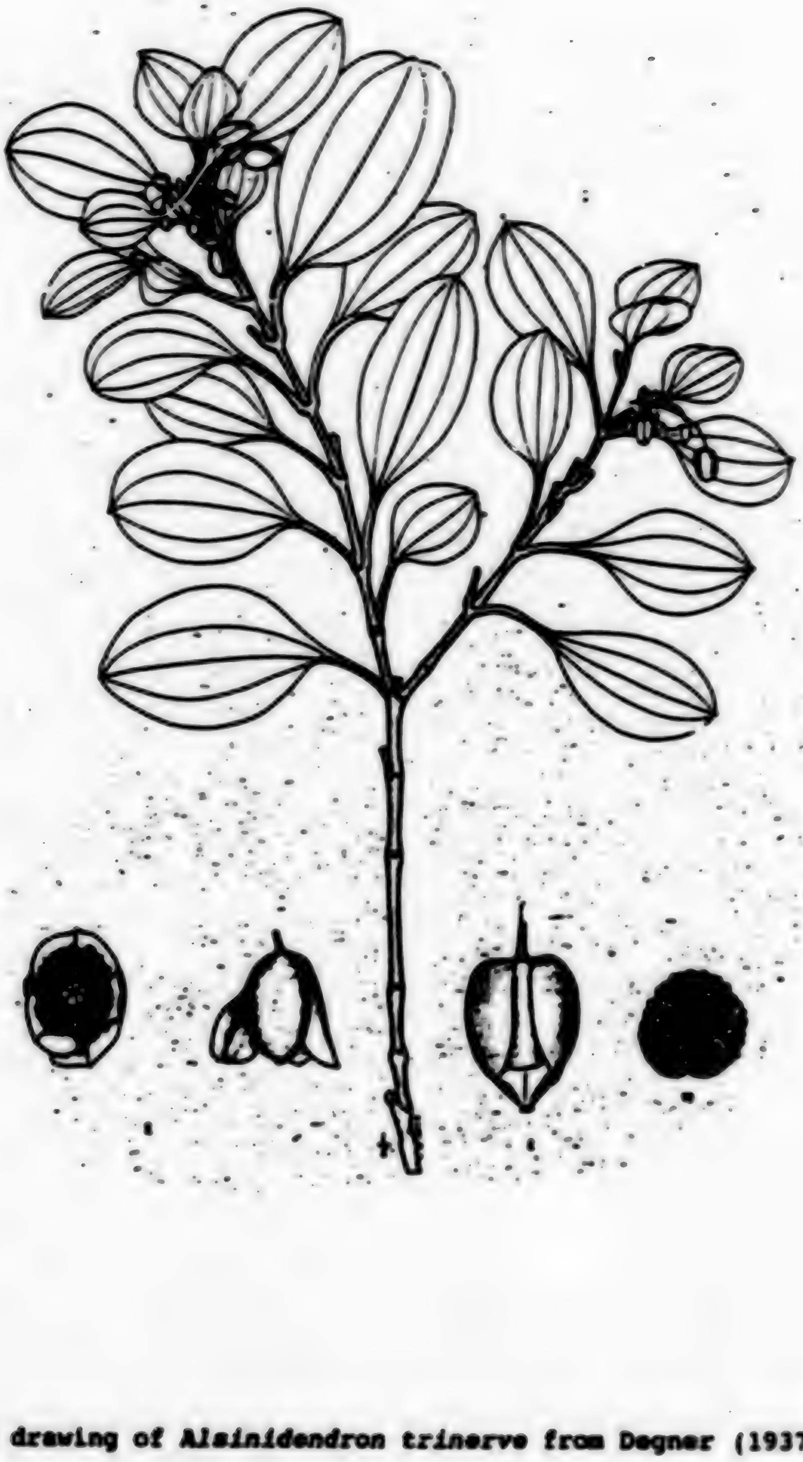
APPENDIX E FIGURES OF PLANTS



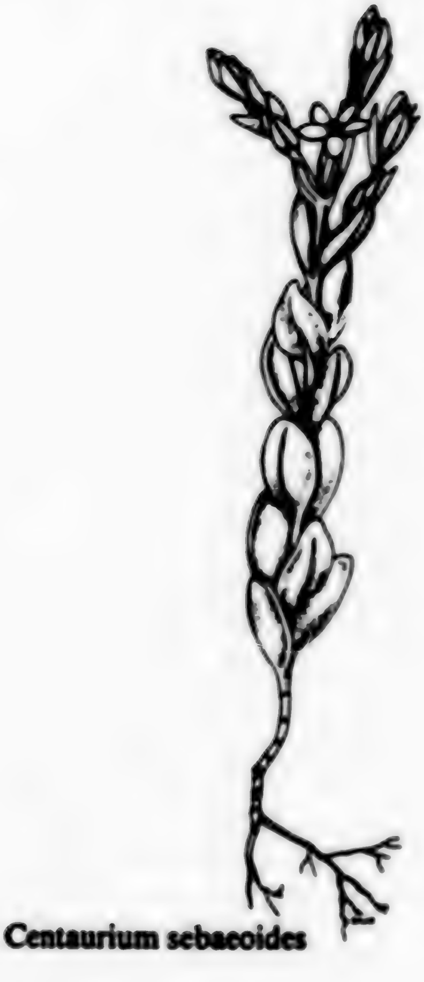
Line drawing of *Abutilon sandwicense* from Wagner et al. (1990).



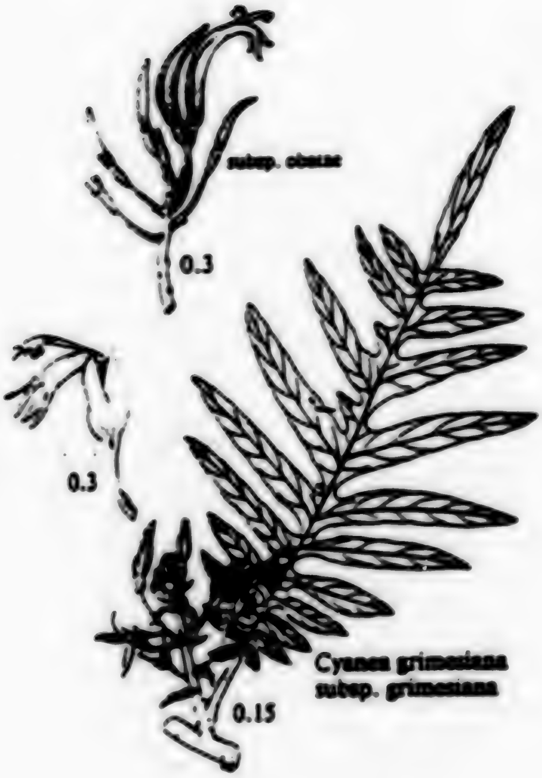
Line drawing of *Alsinidendron obovatum* from Wagner et al. (1990).



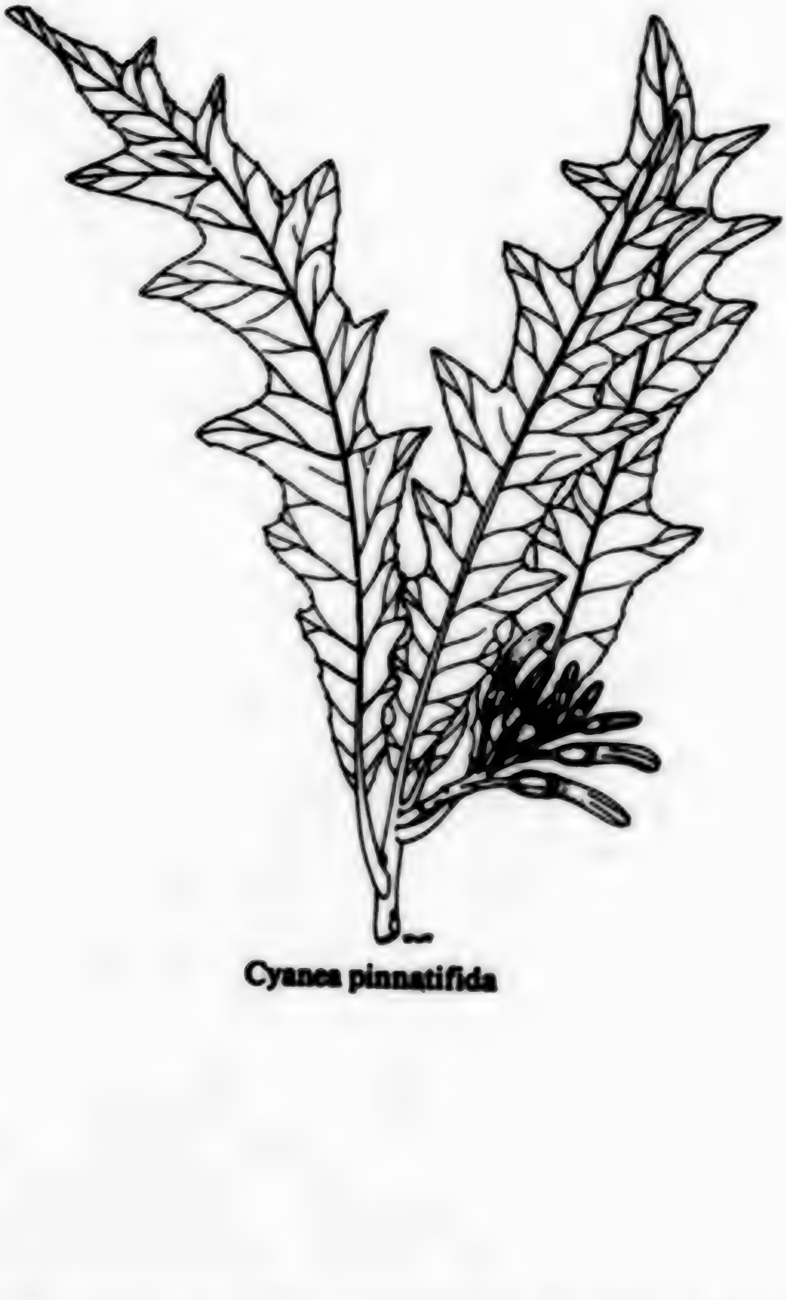
Line drawing of *Alsinidendron trinerve* from Degner (1937).



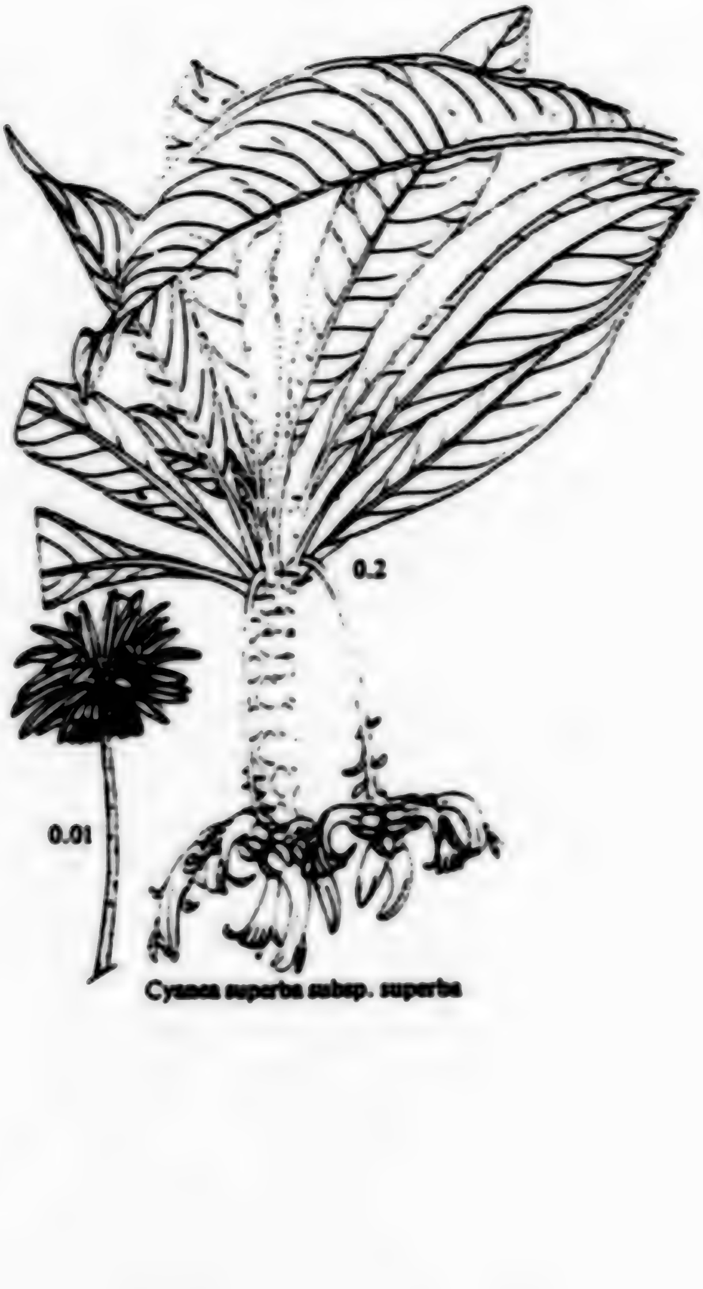
Line drawing of *Centaurium sebaeoides* from Wagner et al. (1990).



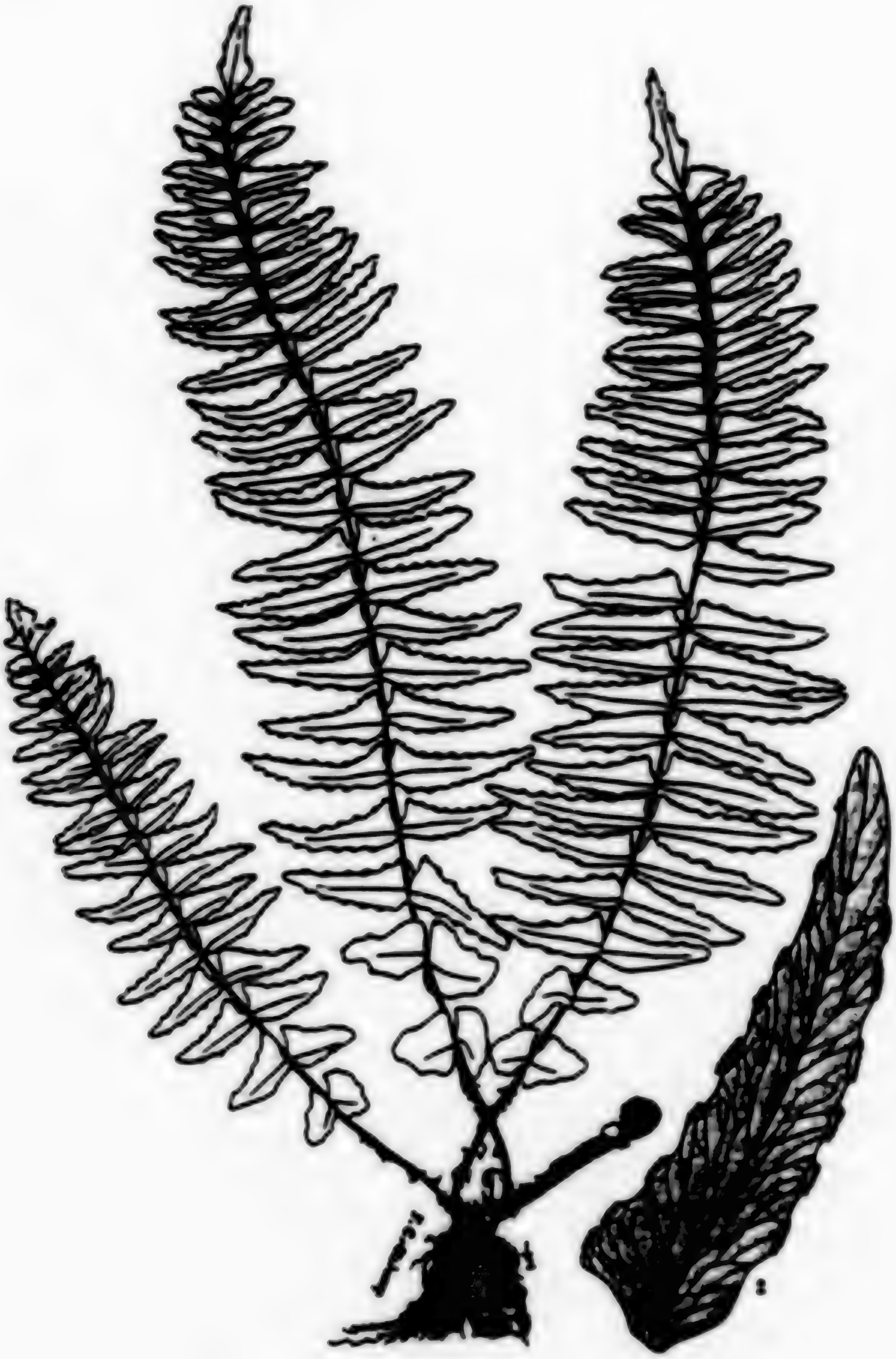
Line drawing of *Cyanea grimesiana* spp. *obatae* from Wagner et al. (1990).



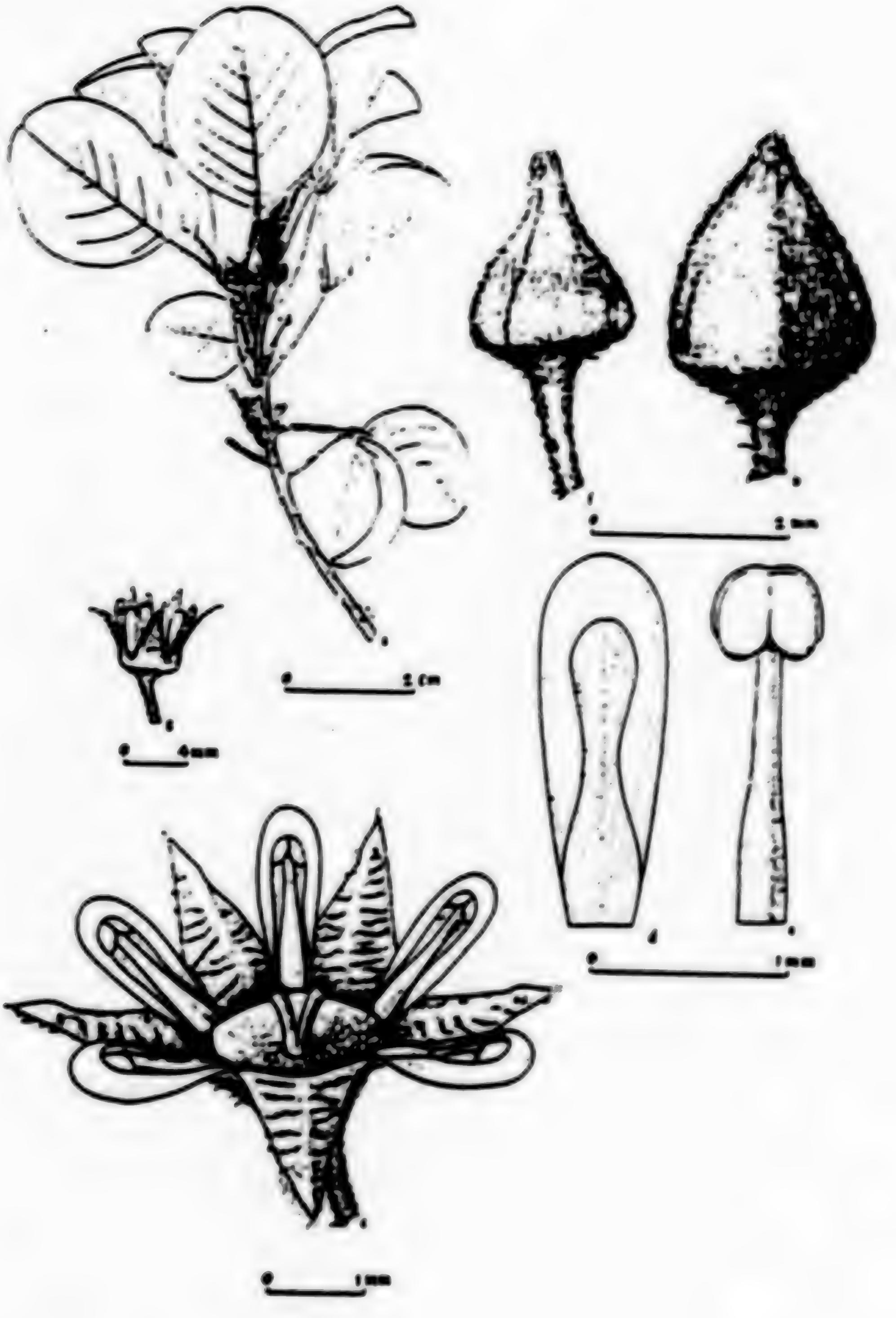
Line drawing of *Cyanea pinnatifida* from Wagner *et al*. (1990).



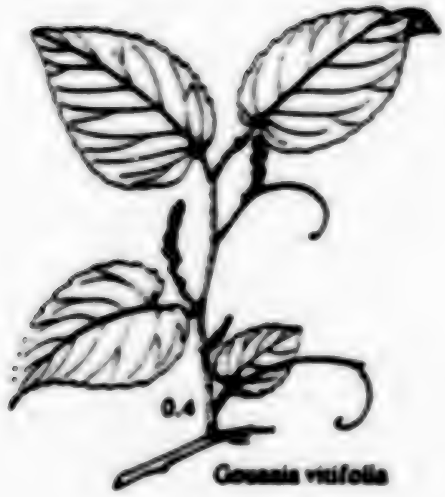
Line drawing of *Cyanea superba* from Wagner et al. (1990).



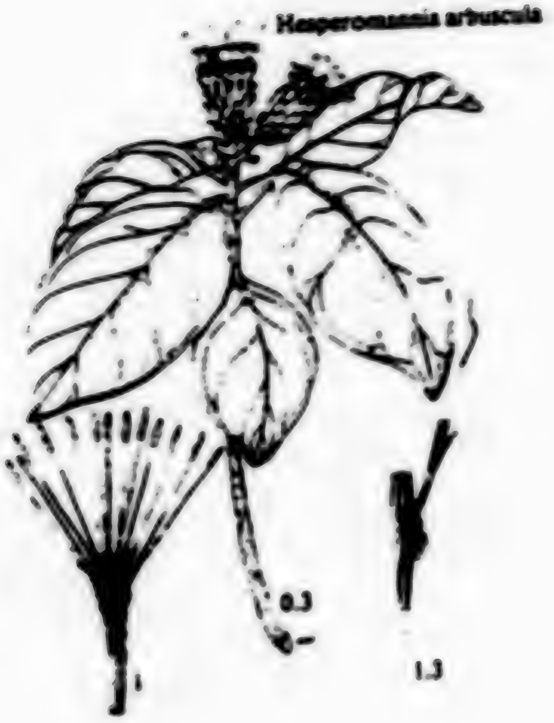
Line drawing of *Diellia falcata* from Degner (1950).



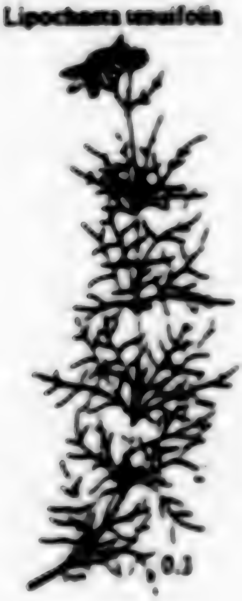
Line drawing of *Gouania meyenii* from St. John (1969).



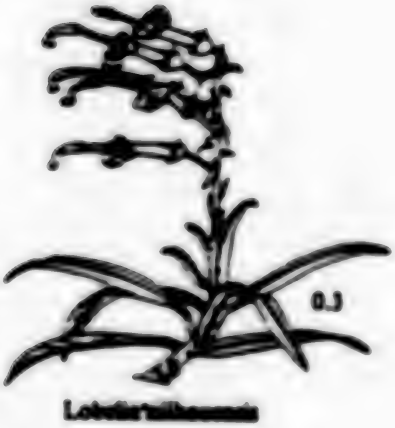
Line drawing of *Gouania vitifolia* from Wagner et al. (1990).



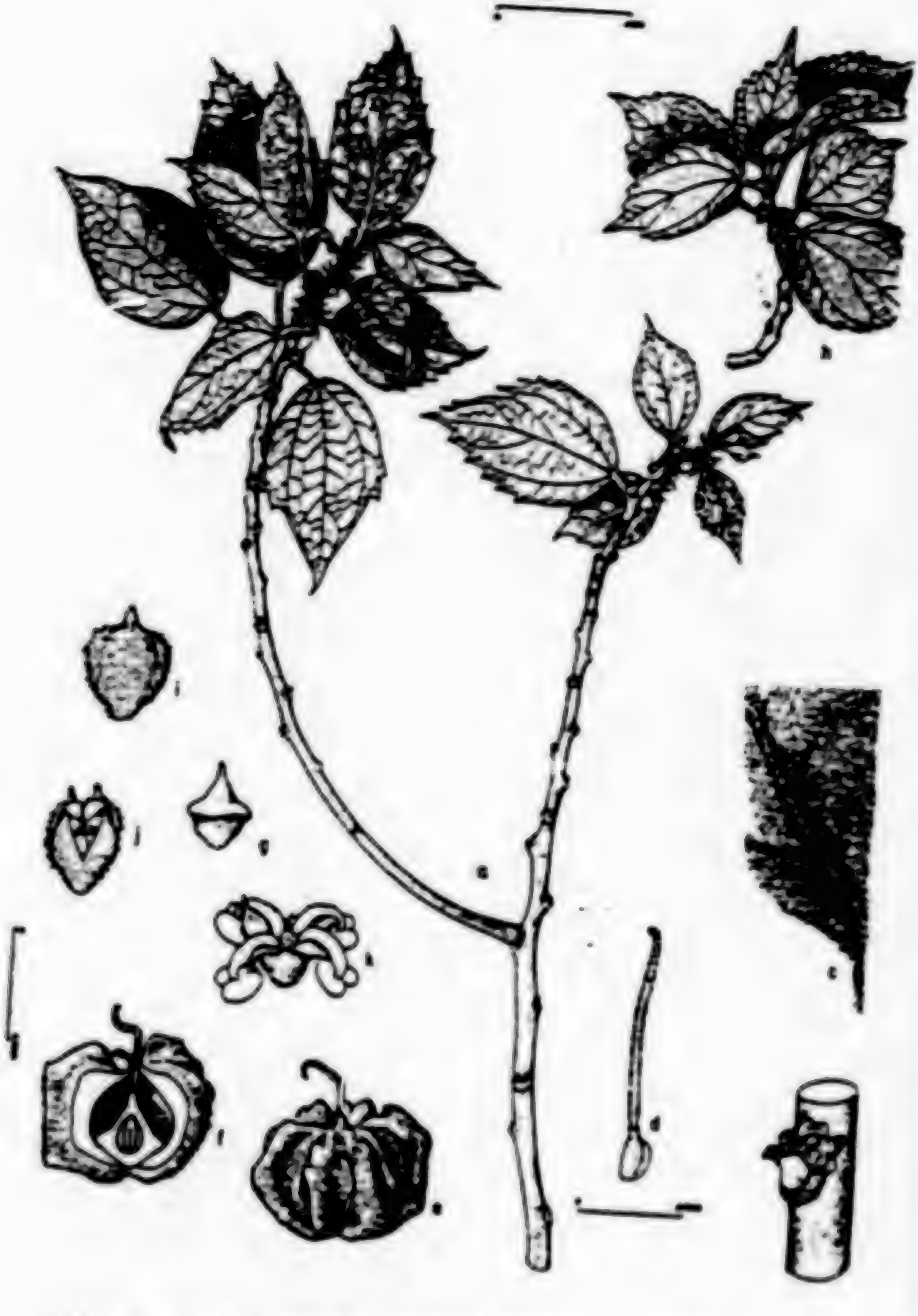
Line drawing of *Hesperomannia arbuscula* from Wagner *et al.* (1990).



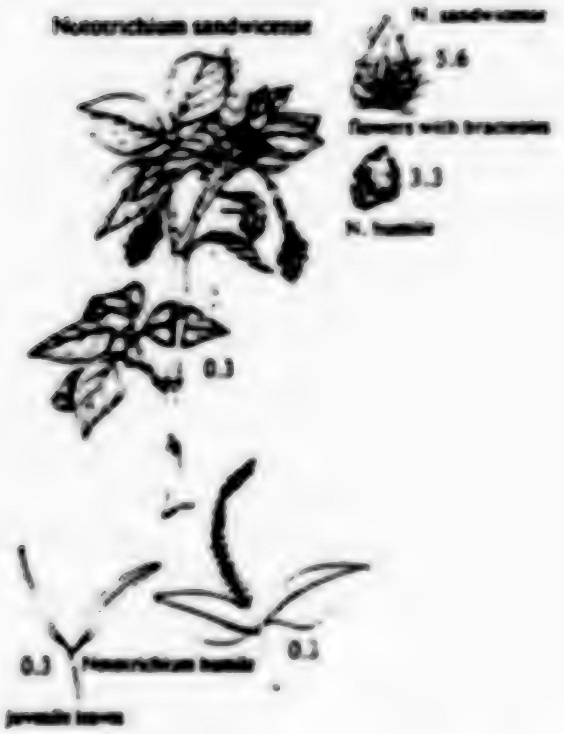
Line drawing of *Lipochaeta tenuifolia* from Wagner et al. (1990).



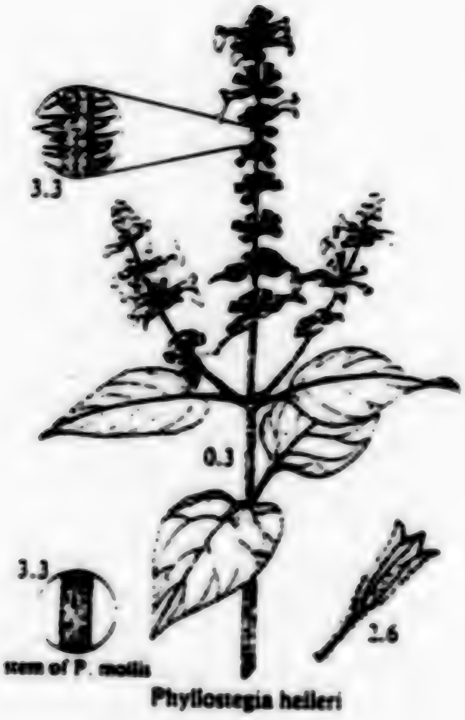
Line drawing of *Lobelia niihauensis* from Wagner *et al*. (1990).



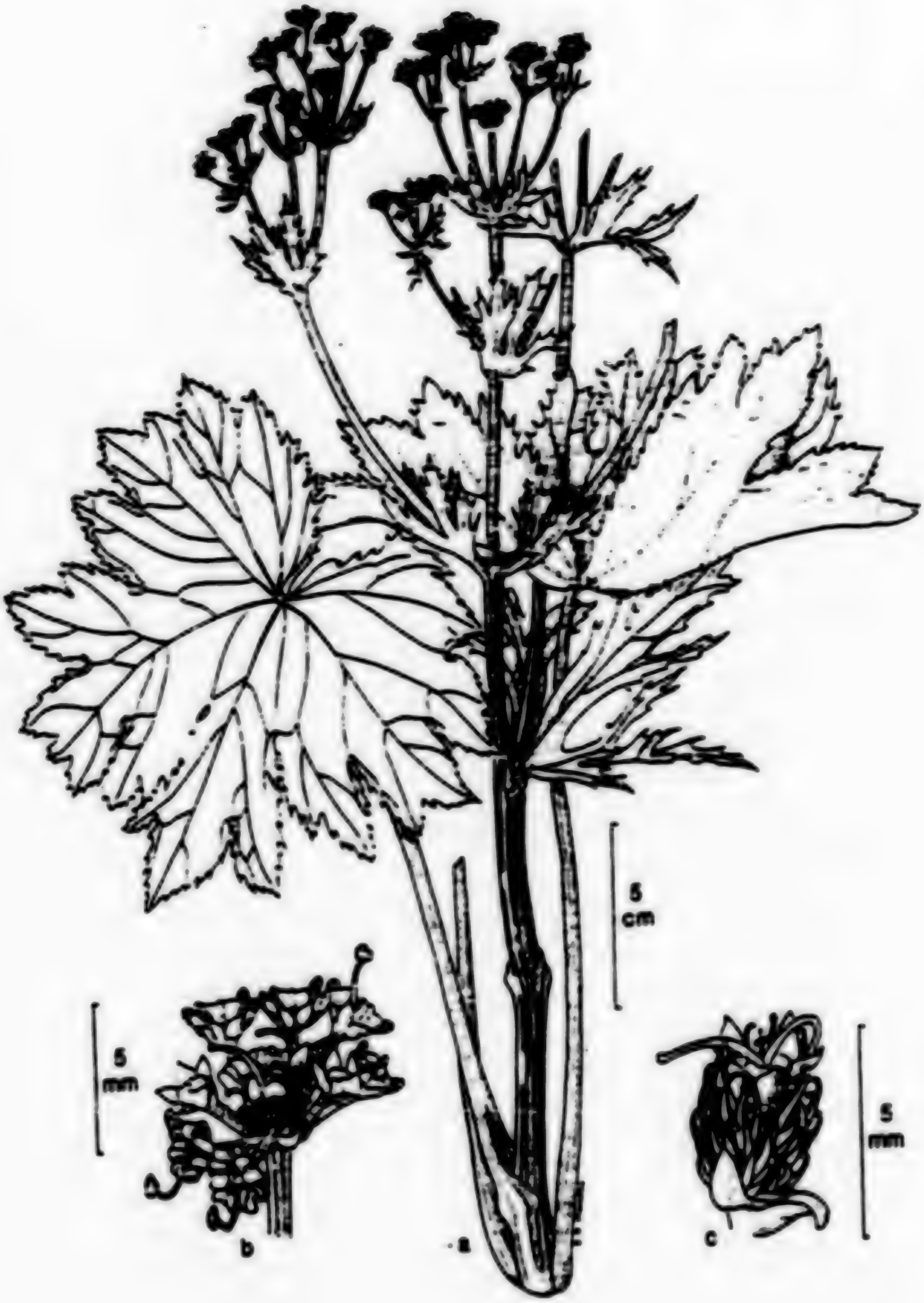
Line drawing of *Neraudia angulata* from Degner (1950).



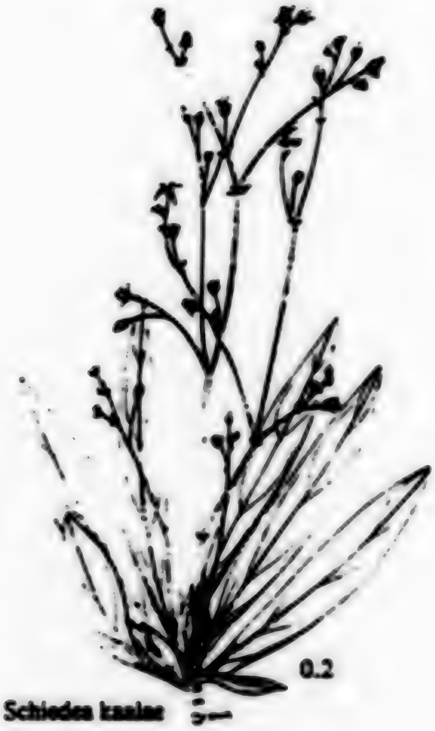
Line drawing of *Nototrichium humile* from Wagner *et al.* (1990).



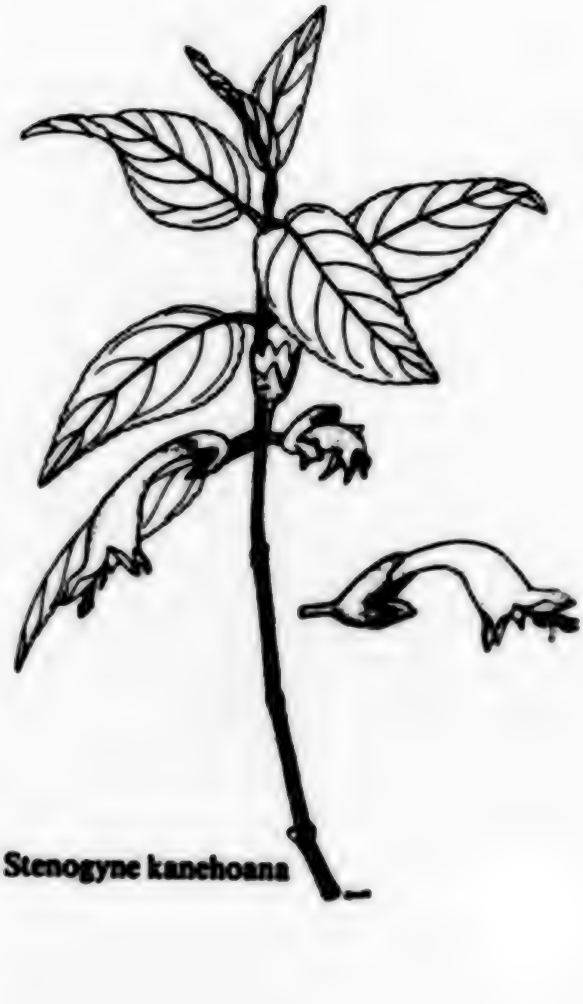
Line drawing of *Phyllostegia mollis* from Wagner et al. (1990).



Line drawing of *Sanicula mariversa* from Nagata and Gon (1987).

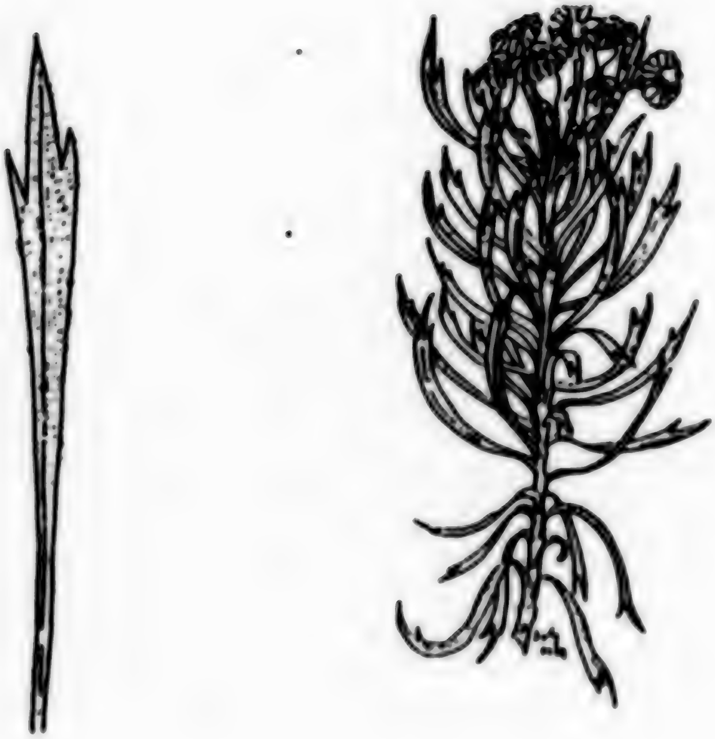


Line drawing of *Schiedea kaalae* from Wagner et al. (1990).

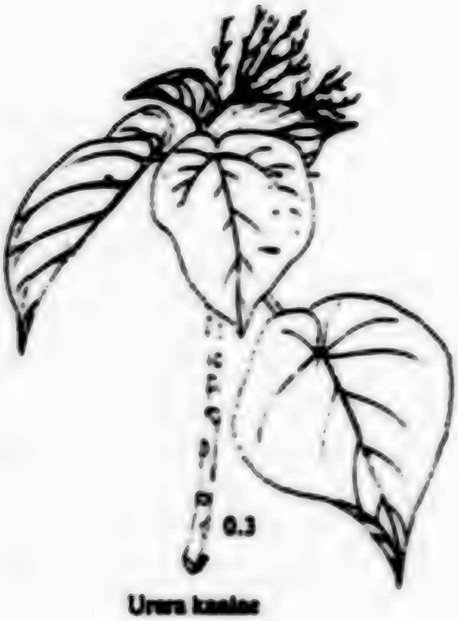


Line drawing of *Stenogyne kanehoana* from Wagner et al. (1990).

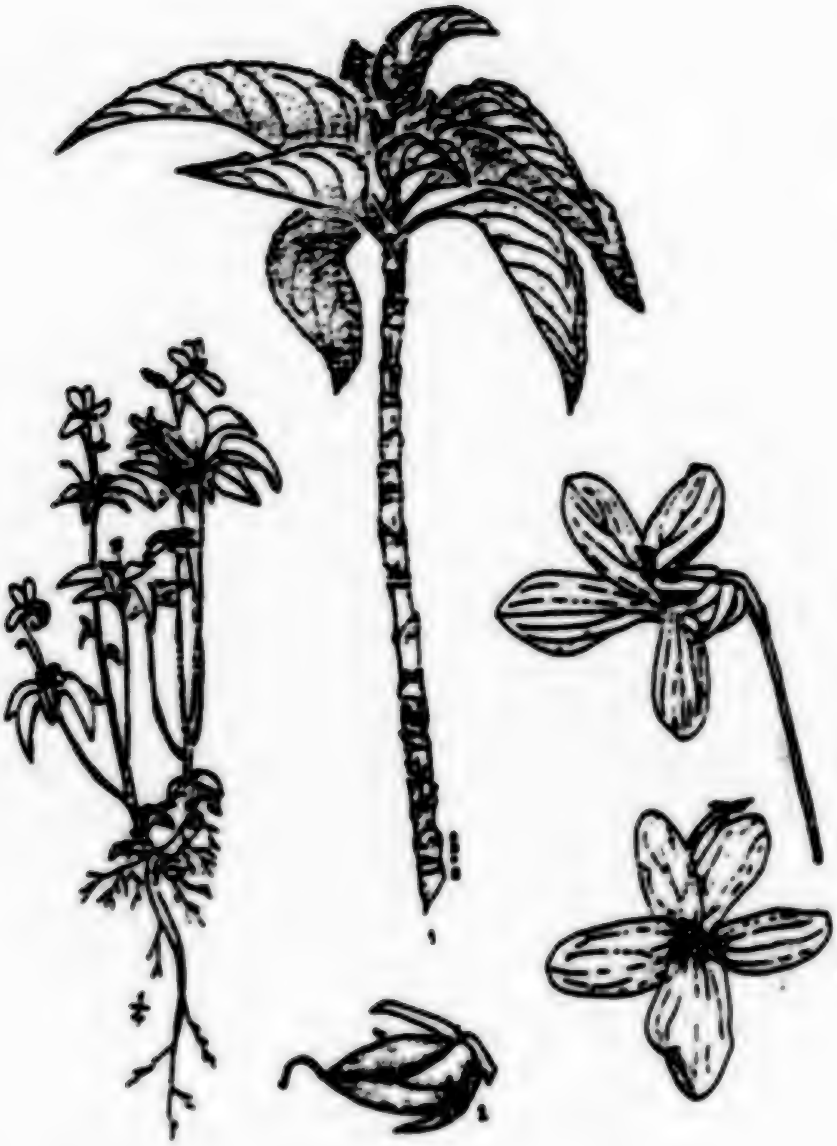
Line drawing of *Tetramolopium filiforme* from Wagner et al. (1990).



Line drawing of *Tetramolopium lepidotum* spp. *lepidotum* from Lowrey (1986).



Line drawing of *Urera kaalae* from Wagner et al. (1990).



Line drawing of *Viola chamissoniana* spp. *chamissoniana* from Degener (1952).

APPENDIX F SUMMARY OF COMMENTS

Comment 1: The ecosystem approach for recovery plans is good, but the Waianae Recovery Plan is too general for managers to use. The draft plan, as written, is extremely convoluted and difficult to comprehend. A more meaningful approach should be taken.

Service Response: The Service agrees that the draft plan was very general and difficult to understand. Based on comments received on the draft and recommendations from the Hawaii and Pacific Plant Recovery Coordinating Committee (HPPRCC), we have rewritten the Waianae Plan in a manner that makes it more specific and understandable to the manager.

Comment 2: Almost all actions listed as priority #1 are management-oriented. Actions involving research are listed as priority #2. It would be a waste of taxpayers' money to allocate funding towards mitigating various threats to species prior to conducting a detailed evaluation of these threats.

Service Response: Priority #1 tasks are defined in the plan as actions that must be taken to prevent extinction or to prevent the species from declining irreversibly. Priority #2 tasks are defined as actions that must be taken to prevent a significant decline in species population/habitat quality, or some other significant negative impact short of extinction. The priority of the Service is to prevent extinctions. Research is often scheduled to be conducted concurrently with management.

Comments 3: Have all landowners been given the chance to provide input on the recovery plan? It is important that they are part of the process.

Service Response: All landowners have been notified and given the chance to comment on the recovery plan. We are hoping that landowners will be instrumental in identifying management areas and will play an active role in the development of specific plans for their area(s).

Comment 4: The U.S. Fish and Wildlife Service is making "commitments" for other agencies and landowners.

Service Response: The Waianae Recovery Plan does not make any commitments for other agencies or entities identified in this plan. The disclaimer at the beginning of the plan states that "Recovery plans delineate reasonable actions which are believed to be required to recover and/or protect listed species. ...Recovery plans do not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service."

Comment 5: How do you decide who pays for what? With the recovery plan as is, the best way to predict costs would be to simply estimate an average cost per species over a twenty year time-frame. Recovery of some of the plant species would likely require much less than these estimated figures.

Service Response: The disclaimer at the beginning of the plan also states "Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Costs indicated for task implementation and/or time for achievement of recovery are only estimates and subject to change."

Comment 6: The draft Waianae Recovery Plan assigns vague locations for 31 species within the Waianae Range. For clarity, the range of each plant should be indicated on maps and provided to the landowner of record.

Service Response: The listing packages for the plants covered by the Waianae Recovery Plan state "the publication of precise maps...would increase the degree of threat to these plants from take or vandalism and, therefore, could contribute to their decline and increase enforcement problems." Therefore, only general locations for each species will be included in the final plan. Specific locations for the species are available in the TNC Heritage Database or from our office on a case-by-case basis.

Comment 7: Why is the Center for Plant Conservation not included in this recovery plan? There's certainly a lot in this plan to be undertaken, and we need everyone's help to gain a better fundamental understanding of the conservation and perpetuation of these rare plants.

Service Response: They have been contacted and are now included in the Waianae Recovery Plan.

APPENDIX G RECOVERY PRIORITY SYSTEM

The Species Recovery Priority System uses the criteria of (1) degree of threat, (2) recoverability, and (3) taxonomy [level of genetic diversity]. By applying these criteria, all listed species are assigned a species priority number of 1 through 18. A fourth factor, conflict, is a supplementary element in determining what actions are to be implemented for recovery of a species. In addition, the fourth factor gives priority, within each category, in preparation of recovery plans to those species that are, or may be in conflict with construction or development projects. Thus, the species retains its numerical rank and acquires the letter designation of "C," indicating conflict (1C-18C).

Recovery Priority System				
Degree of Threat	Recovery Potential	Taxonomy	Priority	Conflict
High	High	Monotypic Genus	1	1C
	High	Species	2	2C
	High	Subspecies	3	3C
	Low	Monotypic Genus	4	4C
	Low	Species	5	5C
	Low	Subspecies	6	6C
Moderate	High	Monotypic Genus	7	7C
	High	Species	8	8C
	High	Subspecies	9	9C
	Low	Monotypic Genus	10	10C
	Low	Species	11	11C
	Low	Subspecies	12	12C
Low	High	Monotypic Genus	13	13C
	High	Species	14	14C
	High	Subspecies	15	15C
	Low	Monotypic Genus	16	16C
	Low	Species	17	17C
	Low	Subspecies	18	18C

END

03-05-98